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THE EQUILIBRIUM MOISTURE OF COPRA AT VARIOUS RELATIVE HUMIDITIES¹

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Of the Department of Agricultural Chemistry

WITH THREE TEXT FIGURES

The degree of saturation of the atmosphere determines the extent to which drying may proceed. If the atmosphere is already heavily laden with moisture (high relative humidity), it may be impossible for drying to take place; instead, moisture may actually be removed from the atmosphere and absorbed by the material being dried. Any hygroscopic material in contact with the atmosphere may, therefore, either gain in moisture content by absorption of water from the atmosphere or decrease in moisture content by desorption of moisture to the atmosphere, depending on the degree of saturation of the surrounding air. A situation may arise where the degree of saturation of the atmosphere and the degree of wetness of the material will be such that no transfer of moisture is possible either way because of the equality of the opposing forces to move moisture. When a material in contact with the atmosphere can neither absorb nor desorb moisture, the moisture content of the material is called the equilibrium moisture. It is known to vary with the relative humidity of the atmosphere. When equilibrium moisture is plotted against relative humidity, the resulting curve is called the equilibrium moisture curve.

Equilibrium moisture curves for carrots, cabbage, sweet potatoes, spinach, and potatoes have been determined by Makower and Dehority (von Loesecke, 1945); for textiles and lumber, by Walker, Lewis, McAdams and Gilliland (1937). Lava (1928) attempted to measure the equilibrium moisture of copra but was unable to determine the relative humidity of his test chambers. According to Brill, Parker and Yates (1917), and Copeland (1921), the equilibrium moisture content of copra is about 5 per cent "under normal Philippine conditions".

The object of this investigation was to determine the equilibrium moisture content of copra at various relative humidities at room temperature and at 40°C. The work was carried out in the Department of Agricultural Chemistry from November, 1946, to December, 1947.

¹Experiment Station Contribution No. 1533. Based on the thesis presented by the senior author for graduation with the degree of Bachelor of Science in Agriculture, October, 1948. Prepared in the Department of Agricultural Chemistry under the direction of the junior author. Read before the Los Baños Biological Club on October 28, 1948.

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MATERIALS AND PROCEDURES

The copra used in this study was prepared from mature nuts by drying in a laboratory oven to a moisture content of about 5 per cent and by sun-drying to a moisture content of about 6 per cent. To hasten the attainment of moisture equilibrium during the tests, the copra was sliced with a razor blade into pieces of about 1 mm. wide, 5 mm. long, and as thick as the original copra. Lava (1928) passed his copra through a meat grinder, a procedure which destroys the natural structure of copra and presses out some of the oil.

One-liter glass jars tightly covered with rubber stoppers were used as test chambers. The relative humidity of the atmosphere inside these chambers was regulated by selected concentrations of sulfuric acid. According to Kohlrausch (1930), the following concentrations of sulfuric acid will maintain the relative humidities indicated at 15°C.:

SULFURIC ACID per cent by wt.	RELATIVE HUMIDITY per cent
0	100
10	95
20	87
30	76
40	57
50	35
60	18
70	7
80	2
96 (conc.)	0

In this study, 100 ml. of each of the above sulfuric acid solutions were placed at the bottom of the test chamber. Actual determination of relative humidity was made for each chamber at the beginning and at the end of the test (table 1), with the use of the dew point method described by Kohlrausch (1930). Determinations at 40°C. required a preliminary warming up of the hygrometer tube to about 45°C., as false dew points were obtained when determinations were made at relative humidities close to 100 per cent. It was also impossible to determine relative humidities much below 18 per cent at room temperature when ether was used as coolant.

The dew point apparatus was constructed from bright, polished, tinned iron sheets. The hygrometer tubes were 2.54 cm. in diameter and 12.70 cm. long. The dew point apparatus is shown in figure 1a.

For tests at 40°C. a water thermostat was constructed from galvanized iron. The tank, with a glass window, was 62 cm. in diameter and 28 cm. deep. Constant temperature was maintained by means of a chromel heating coil immersed directly into the water and by an inflow of cold water. The test chambers were strapped to a revolvable metal shelf of the same diameter as the tank and raised 10 cm. from the bottom of the tank. By revolving the metal shelf, any test chamber could be placed in front of the glass window for observation as shown in figure 1b.

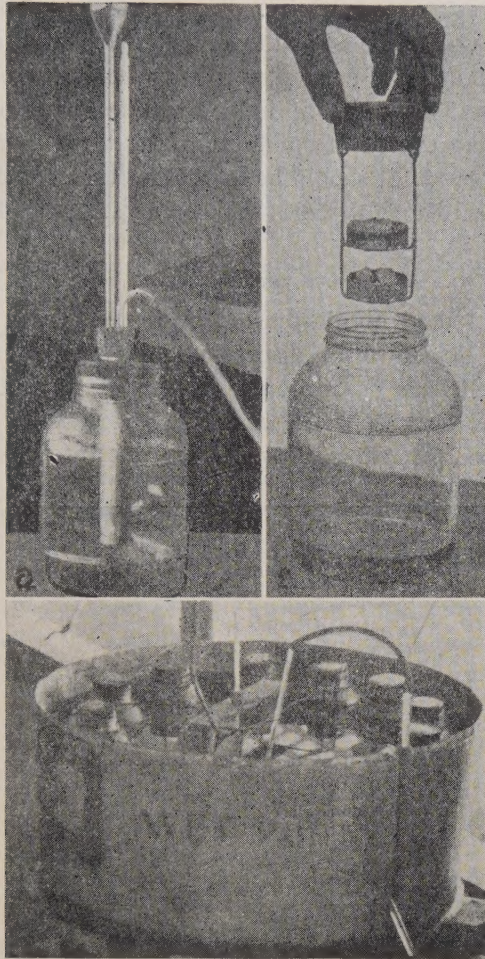


Fig. 1.—Apparatus for the determination of equilibrium moisture of copra: (a) Dew point apparatus for determination of relative humidity within a test chamber. (b) Water thermostat with test chambers in place. (c) Sample holder for the copra.

Procedure

After the relative humidity in the test chambers had been found constant, the sample, weighed in duplicate, and contained in a especially designed holder (fig. 1c), was introduced into the test chamber. At 7-day intervals, the sample container was removed, covered, and weighed quickly. The weekly weighings were continued until weights differed not more than 0.2 mg. from the preceding one. The relative humidity of the air inside the test chambers was determined at the termination of each test. The moisture contents of the copra samples were determined by drying at 100°C.

in an oven to a constancy of 0.2 mg. The drying time was kept to a minimum in order to avoid error arising from volatilization of coconut oil. The final moisture contents of the samples were taken as the equilibrium moisture. The weight of this moisture divided by the anhydrous weight of the sample gives the percentage of equilibrium moisture. Typical results of a test are given in table 2. It should be noted that the percentage equilibrium moisture is calculated on dry basis in keeping with the literature on the subject.

DISCUSSION OF RESULTS

A summary of data obtained from eight tests, each in duplicate, is given in table 3. Results from absorption tests were found to agree well with those obtained from desorption tests, indicating that a true moisture equilibrium existed between copra and the atmosphere. The equilibrium moisture curves are plotted in figures 2 and 3. Interpolated values read

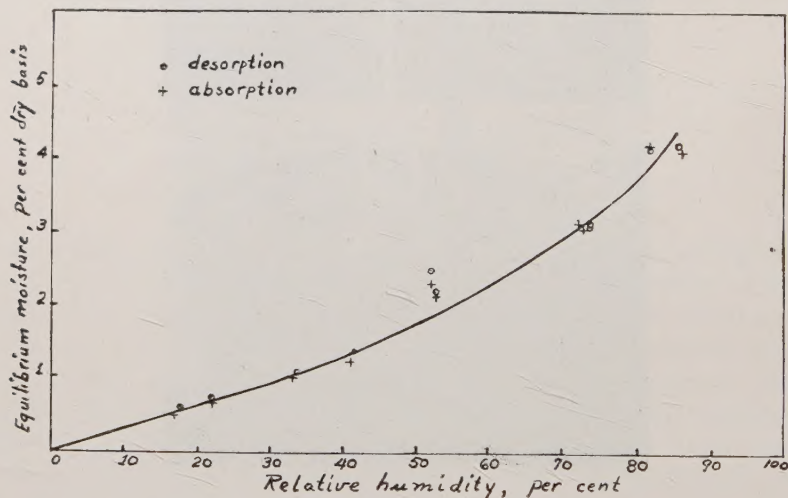


Fig. 2.—Equilibrium moisture curve for copra at room temperature, $28.5^{\circ}\text{C.} \pm 3.5^{\circ}\text{C.}$

from the curves and taken at intervals of 5 units of relative humidity, are given in table 4. It was found impossible to determine equilibrium moisture at relative humidities above 85 per cent at room temperatures on account of the appearance of molds on the samples. In the tests conducted at 40°C. molds appeared at relative humidities above 94 per cent. These results indicate that copra is susceptible to mold attack regardless of its moisture content if it is stored where the relative humidity is above 85 per cent at room temperature or above 94 per cent at 40°C. unless the copra is sterile or free from fungal infection.

Equilibrium moisture curves give valuable information regarding gain or loss of moisture by a given material stored in a space of known relative humidity.

Example 1. Calculate loss of weight which will be sustained by 100 kg. of copra whose moisture content on dry basis is 10 per cent, when stored at room temperature in a space with relative humidity of 80 per cent. Figure 2 or table 4 shows that at a relative humidity of 80 per cent the equilibrium moisture at room temperature is 3.73 per cent. The moisture in the copra will, therefore, be reduced from 10 per cent to 3.73 per cent, or a loss of 6.27 kg. per 100 kg. of dry copra. Since the original copra contained 100 kg. dry matter and 10 per cent moisture, the proportion $6.27:110::x:100$ gives the loss for 100 kg. original copra, which amounts to 5.70 kg. moisture.

Example 2. At what relative humidity should copra be stored so that the copra will have a constant moisture content of 3 per cent (dry basis)? Figures 2 and 3 show that the desired moisture content can be maintained

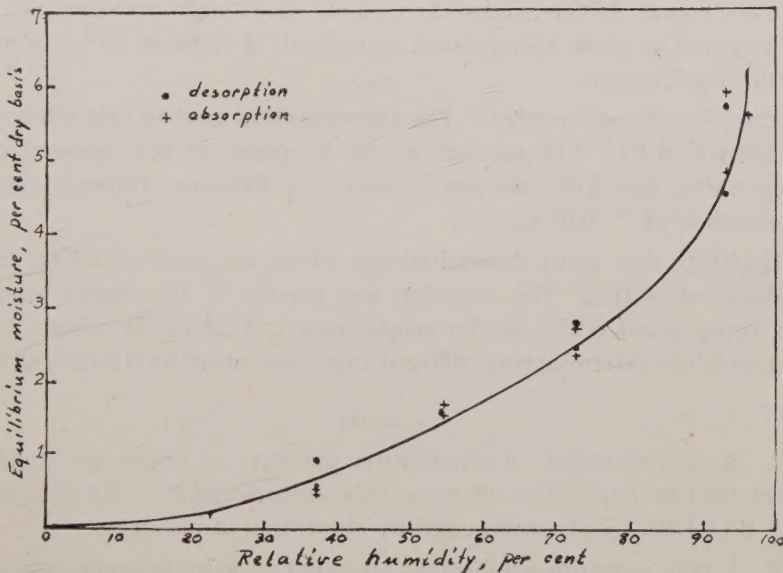


Fig. 3.—Equilibrium moisture curve for copra at $40^{\circ}\text{C.} \pm 2^{\circ}\text{C.}$

by storing the copra in a space with relative humidity of 70 per cent at room temperature or a relative humidity of 80 per cent at 40°C.

If moisture contents are expressed on wet basis, an increase in weight of copra due to absorption of moisture may be derived as follows:

Let W = weight of copra

P = percentage of moisture of the copra

X = increase in weight of the copra due to absorption of moisture

P_e = equilibrium moisture

Therefore, PW = weight of water in the copra

$PW + X$ = weight of water in the copra after moisture has been absorbed

$W + X$ = final weight of copra

$P_e (W + X)$ = total weight of water in the copra after absorption of moisture.

Therefore, $PW + X = P_e (W + X)$

And solving, $X = \left(\frac{P_e - P}{1 - P_e} \right) W$

In the case of loss of weight of copra due to desorption of moisture, an equation may similarly be derived:

$$X = \left(\frac{P - P_e}{1 - P_e} \right) W.$$

Attention is called to the requirement that, for the equilibrium curve to be applicable, the copra must first attain moisture equilibrium with the storage atmosphere. The rate of drying or absorption of moisture will vary according to conditions of temperature, relative humidity, aeration and size of the copra. In this study where thinly sliced copra was used, 21 days were required at room temperature and about 14 days at 40°C. to attain moisture equilibrium.

Precision of measurements. The thermometers used in this study were graduated to 0.1°C. Comparisons at the ice point, at the temperature of boiling water, and 30°C. showed a maximum difference between the two thermometers of $\pm 0.05^\circ\text{C}$.

Replicate dew point determinations varied as much as 2.5°C. in the neighborhood of 0°C. The variation was smaller at the higher temperatures, being about 0.2°C. in the neighborhood of 23°C. Duplicate equilibrium moisture determinations differed from each other by 0.5 unit at most.

SUMMARY

1. A determination of equilibrium moisture of copra was made at various relative humidities, at room temperature ($28.5 \pm 3.5^\circ\text{C}$.) and at $40^\circ \pm 2^\circ\text{C}$. both by absorption and by desorption of moisture.

2. A true moisture equilibrium appeared to exist between copra and the atmosphere. Two equilibrium moisture curves were plotted for copra, one within the range of 0 to 85 per cent relative humidity at room temperature, and the other within the range of 0 to 95 per cent relative humidity at 40°C. Equilibrium moisture determinations could not be made at the higher relative humidities because of the appearance of, and attack by, molds.

When the relative humidity was greater than 85 per cent at room temperature or greater than 95 per cent at 40°C., molds attacked the copra samples regardless of their initial moisture contents.

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TABLE 2
Results of test 1: loss in weight (desorption) of copra stored at various relative humidities (R. H.) at room temperature and the final equilibrium moisture

TEST CHAMBER NUMBER	WEIGHT OF SAMPLE							EQUILIBRIUM MOISTURE per cent	AVERAGE EQUILIBRIUM MOISTURE per cent	R. H. per cent	TEMPERATURE OF R. H. DETERMINATIONS °C.
	Initial	7 days	14 days	21 days	28 days	35 days	Dried at 100°C.				
	grams	grams <i>b</i>	grams	grams	grams	grams	grams				
1	0.9998	<i>b</i>	—	—	—	—	—	—	—	—	—
	1.0012	<i>b</i>	—	—	—	—	—	—	—	—	—
2	1.0028	<i>c</i>	—	—	—	—	—	—	—	—	—
	1.0026	<i>c</i>	—	—	—	—	—	—	—	—	—
3	1.0054	0.9913	0.9901	0.9894	0.9893	0.9897	0.9508	4.09	4.16	82.1	32.0
	1.0024	0.9878	0.9873	0.9866	0.9864	0.9865	0.9465	4.23			
4	1.0014	0.9798	0.9779	0.9771	0.9766	0.9766	0.9465	3.18	3.17	73.5	32.0
	1.0016	0.9799	0.9774	0.9764	0.9758	0.9758	0.9460	3.15			
5	1.0005	0.9713	0.9699	0.9693	0.9691	0.9692	0.9460	2.45	2.50	52.5	32.5
	1.0008	0.9725	0.9715	0.9710	0.9707	0.9707	0.9466	2.55			
6	1.0009	0.9660	0.9631	0.9626	0.9624	0.9625	0.9508	1.23	1.38	42.2	31.8
	1.0041	0.9693	0.9677	0.9609	0.9607	0.9607	0.9472	1.42			
7	0.8985	0.8598	0.8536	0.8521	0.8524	0.8521	0.8455	0.78	0.71	22.0	31.3
	1.0015	0.9621	0.9570	0.9553	0.9554	0.9553	0.9492	0.64			
8	1.0017	0.9511	0.9459	0.9449	0.9450	0.9449	0.9444	0.05	0.05	0.0	31.3
	1.0019	0.9530	0.9463	0.9458	0.9459	0.9458	0.9453	0.05			

^aInitial moisture content of oven-dried copra samples = 5.22 per cent.

^bMolds observed on the fourth day.

^cMolds observed on the fifth day.

TABLE 3
Summary of results of the determination of equilibrium moisture (E.M.)

	AT ROOM TEMPERATURE				AT 40°C.		
	R.H.	E.M.	Temp. ^a	Initial moisture	R.H.	E.M.	Initial moisture
	per cent	per cent	°C.	per cent	per cent	per cent	per cent
Desorption.....	0.0 0.0	0.00 0.00	31.3 29.8	5.22 6.14	0.0 0.0	0.00 0.00	3.91 3.94
Absorption.....	0.0 0.0	0.00 0.00	31.0 28.0	0.00 0.00	0.0 0.0	0.00 0.00	0.00 0.00
Desorption.....	22.0 18.1	0.71 0.59	31.3 29.8	5.22 6.14	22.5 22.5	0.26 0.26	3.91 3.94
Absorption.....	22.0 17.3	0.70 0.52	31.0 28.0	0.00 0.00	22.5 22.5	0.23 0.22	0.00 0.00
Desorption.....	42.2 34.1	1.38 1.11	31.8 29.8	5.22 6.14	36.9 36.9	0.60 0.96	3.91 3.94
Absorption.....	41.5 33.5	1.25 1.05	30.5 28.0	0.00 0.00	36.9 36.9	0.55 0.47	0.00 0.00
Desorption.....	52.5 53.1	2.50 2.23	32.5 29.8	5.22 6.14	54.6 54.6	1.71 1.61	3.91 3.94
Absorption.....	52.5 53.0	2.29 2.15	30.5 28.0	0.00 0.00	54.6 54.6	1.68 1.34	0.00 0.00
Desorption.....	73.5 73.9	3.17 3.13	32.0 29.5	5.22 6.14	72.6 72.6	2.56 2.86	3.91 3.94
Absorption.....	72.6 73.2	3.15 3.05	31.0 28.2	0.00 0.00	72.6 72.6	2.43 2.78	0.00 0.00
Desorption.....	82.1 85.9	4.16 4.18	32.0 29.5	5.22 6.14	93.3 93.3	5.82 4.61	3.91 3.94
Absorption.....	82.1 85.6	4.17 4.08	30.0 28.0	0.00 0.00	93.3 93.3	5.97 4.87	0.00 0.00
Desorption.....	— —	— —	— —	— —	96.0 96.0	6.29 6.30	3.91 3.94
Absorption.....	— —	— —	— —	— —	94.0 94.0	5.71 5.73	0.00 0.00
Desorption.....	— —	— —	— —	— —	97.0 97.0	(15.43) ^b (15.44)	3.91 3.94
Absorption.....	— —	— —	— —	— —	97.0 97.0	(16.23) (16.61)	0.00 0.00
Desorption.....	— —	— —	— —	— —	100.0 100.0	(20.30) (20.58)	3.91 3.94
Absorption.....	— —	— —	— —	— —	100.0 100.0	(19.37) (21.76)	0.00 0.00

^aTemperature when final relative humidity was determined.

^bFigures enclosed in parentheses indicate moisture content of the samples when molds were first observed growing on them.

TABLE 4

Interpolated values of equilibrium moisture content of copra corresponding to various relative humidities as obtained from the equilibrium moisture curves

RELATIVE HUMIDITY	EQUILIBRIUM MOISTURE PERCENTAGE			
	At room temp.		At 40°C.	
	Dry basis	Wet basis	Dry basis	Wet basis
<i>per cent</i>				
10	0.32	0.32	0.11	0.11
20	0.65	0.65	0.23	0.23
25	0.80	0.79	0.32	0.32
30	0.96	0.95	0.45	0.45
35	1.10	1.09	0.60	0.60
40	1.30	1.28	0.78	0.77
45	1.55	1.53	0.99	0.99
50	1.80	1.77	1.21	1.20
55	2.05	2.00	1.48	1.46
60	2.31	2.26	1.80	1.77
65	2.61	2.54	2.09	2.05
70	2.96	2.87	2.41	2.35
75	3.32	3.21	2.74	2.67
80	3.73	3.60	3.13	3.04
85	4.30	4.12	3.60	3.47
90	—	—	4.26	4.09
95	—	—	6.00	5.66

AN ECONOMIC AND SOCIAL STUDY OF TOBACCO FARMING IN ISABELA^{1, 2}

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Tobacco, one of the export crops of the Philippines, is the principal cash crop of the farmers in Cagayan Valley. A study of the economic and social conditions of tobacco farmers will give a clear understanding of their problems and needs, which will provide a good basis for formulating an effective program of improvement.

Very little investigation has been conducted on the economic and social conditions of tobacco growers. Madamba³ investigated the cost of producing tobacco on one hundred tobacco farms in Ilagan, Isabela. His findings showed that the average area planted to this crop on a farm was 0.955 hectares. The cost of production of a hectare to the tenant was ₱311.82; the yield of tobacco leaf a hectare, 591.1 kilograms.

Mabbun⁴ studied the Tobacco Growers Association, Incorporated, one of the co-operative associations in Tuguegarao, Cagayan. He reported that the members received better prices for their tobacco, and that they were granted loans by the association. The members sold through this association to the Alhambra Cigar and Cigarette Manufacturing Company tobacco valued at ₱64,302, or an average of ₱142.89 a member.

Object of the study

The principal object of the investigation was to study: (a) the economic conditions of tobacco farmers, such as type of farming, size of farm, crops grown, livestock raised, farm practices, labor income, family income, relation of various factors to labor earnings, cost of production, and labor requirements; and (b) their social conditions, such as type of household, nature of dwellings, household facilities, school attendance and educational attainment, reading matter in the home, membership in organizations, and recreational activities.

MATERIALS AND METHOD

The study was conducted from June, 1946, to June, 1947. The major part of the field survey work was conducted in the municipalities of Angadanan and San Mateo, province of Isabela. Three hundred and five farms were included in this study.

¹ Experiment Station Contribution No. 1534.

² Read before the Los Baños Biological Club on January 28, 1949.

³ Abstract reported in *Philippine Agric.* **16**: 495-496. 1928.

⁴ MABBUN, PABLO N. 1927. A study of the Tobacco Growers Association, Inc. of Tuguegarao, Cagayan. *Philippine Agric.* **16**: 19-34.

The survey method of investigation was employed. Data secured through interview with farmers, their wives, and their children were recorded in a survey form prepared for the purpose. These farmers were residing in the *poblacions* and in 15 barrios, all in the tobacco-growing districts of these municipalities.

RESULTS AND DISCUSSION

Population

Of the 305 farm operators, 300 were male. The age ranged from 17 to over 80 years. The average age was 44.2 years.

The 305 families had a total membership of 1,705 persons, of which 54.5 per cent were male.

Of the 305 farm operators, 20.3 per cent were born in the barrio where they were residing. The proportion of those born in the municipality was 33.2 per cent. About 49.2 per cent were born in places outside the province.

On the average, the operators in the barrio had resided there for 25.3 years. The average length of residence in the municipality of the 305 operators was 26.3 years.

Economic conditions

Of the 305 farm operators, 199, or 65.2 per cent, were owners of the farms they were cultivating. About 13.5 per cent were part-owners; 20 per cent, share tenants; and 1.3 per cent, cash renters.

Based on the value of products raised on the farm, the 305 farms fell under the following types: tobacco, 56.7 per cent; corn-tobacco, 28.5 per cent; tobacco-sugar cane, 3.3 per cent; tobacco-rice, 2.3 per cent; other types, 9.2 per cent.

The area of farms ranged from 1 to over 20 hectares. The average size of the farms was 5.77 hectares. Only 22.2 per cent of the farms were more than five hectares in size. Of the 5.77 hectares, only 2.83 were crop land, of which 1.17 hectares were planted to tobacco. The remaining area consisted of pasture, idle land, farmstead, and garden. The farm area was utilized as follows: crops, 48.6 per cent; farmstead, garden, and orchard, 6.5 per cent; pasture and idle land, 43.1 per cent; woods, 1.8 per cent.

The total investment in each farm averaged ₱2,860.67. Of this amount, 32.5 per cent were in land; 25.8 per cent, in buildings; 17.8 per cent, in work animals; and 9.8 per cent, in other livestock. Of the amount invested in a farm, 94.8 per cent was owned by the operator. The operators owned the buildings and tools, practically all of the work animals, livestock, seeds, and supplies, and 84.7 per cent of the amount invested in land.

Classified according to tenure, the capital investment was as follows: owner, ₱3,294.18; part-owner, ₱2,070.24; cash renter, ₱1,986.23; and tenant, ₱1,275.44.

All the farmers grew tobacco on an area averaging 1.17 hectares. The other important crops were corn, rice, and legumes. Corn was grown by 99.7 per cent of the farmers on an area averaging 1.37 hectares. Lowland rice was grown by 54.7 per cent on an average area of 0.72 hectare. The area planted to mungo, peanut, and cowpea averaged 0.35 hectare.

The majority of the farmers raised vegetables, principally eggplant and tomatoes. Only few farmers raised patola, squash, ampalaya, and upo.

Banana was the most common fruit crop. It was raised by 20.3 per cent of the farmers. About 16.4 per cent had citrus trees in their yards. A limited number of farmers raised pineapple, papaya, nangka, mango, star apple, siniguelas, guayabano, and breadfruit. Coffee was grown by 13.1 per cent of the farmers.

Of the livestock, carabao was the most common, being the principal work animal in the region. It was found on 97.4 per cent of the farms. The average number on each farm was 2.02. Cattle was also used as work animal on 28.2 per cent of the farms. The average number on each farm was 0.40. About 97.4 per cent of the farmers raised chickens. The average number of hens on each farm was 6.49. Swine was raised by 96.4 per cent of the farmers. The average number on each farm was 3.54. There were only few horses, goats, and ducks.

The farm receipts, which consisted of cash sales from crops, vegetables, fruits, livestock, and increase of capital, averaged ₱1,063.54 for each farm. Of this amount, 83.8 per cent came from sales of farm crops and 11.8 per cent, from sales of livestock and livestock products. This average excluded the products used at home. The principal source of cash income was tobacco. Of the ₱918.88 derived from crop products, ₱445.63, or 48.3 per cent, came from tobacco. Corn contributed 25.8 per cent of the receipts from crops; rice, lowland and upland, 12.2; peanut, 4.7; sugar cane, 3.2; mungo, 2.2; fruits, vegetables, and other crops, 3.5.

The total farm receipts on each farm according to tenure was as follows: owner, ₱1,137.49; part-owner, ₱817.87; tenant, ₱965.70; cash renter, ₱1,490.38.

The farm expenses, which consisted of cash expenses, unpaid family labor, decrease of capital, harvester's share, and land rent or landlord share, averaged ₱530.06. Of this amount, unpaid family labor constituted 41.1 per cent; decrease of capital, 22.5; cash land rent and landlord share, 20.5; cash expenses, 13.1; and harvester's share, 2.8. The average expenses for each farm according to tenure were as follows: owner, ₱477.92; part-owner, ₱560.28; tenant, ₱673.59; cash renter, ₱1,242.50.

The labor income of each farm averaged ₱383.46. This is what the farm operator received for his year's work, excluding the interest on the investment and farm expenses, in addition to having a house to live in

and farm products to use at home. The owner-operator's labor income, ₱474.15, was much higher than that of the other types of operators.

The farm privileges, which consisted of farm products used at home and the rental value of the dwelling, amounted, on the average, to ₱638.72 for each farm. Of this amount, 75.1 per cent were farm crops; 13.9, rental value of dwelling; 5.9, livestock and livestock products; and 5.1, vegetables and fruits.

About one-third of the crops, vegetables, and farm products was used at home. Of the farm products valued at ₱1,589.21, 32.3 per cent was used at home.

The gross farm earnings, or farm receipts and privileges, amounted, on the average, to ₱1,702.26 for each farm. After deducting farm expenses and interest on capital, the balance, which was the operator's labor earnings from the farm, amounted to ₱1,022.18. The owner-operators realized the highest labor earnings, amounting to ₱1,168.36. The labor earnings of the other types of operators were as follows: part-owner, ₱768.97; cash renter, ₱691.55; tenant, ₱683.34.

The average family income amounted to ₱1,307.12. This included the operator's labor earnings from the farm and his income from jobs off the farm, the income of other members of the family, and income from other sources. Of the family income, 78.4 per cent came from the operator's labor earnings and 2.2 per cent from his income from jobs off the farm, or a total of 80.6 per cent.

The family income of the owner-operator was ₱1,478.44, which was higher than that of other operators. The part-owner had a family income of ₱1,007.08; tenant, ₱902.62; cash renter, ₱1,024.30.

In addition to the family income, certain amounts were available for living expenses. These were the interest earned by the operator's capital, which amounted to ₱150.02 for each farm. When this amount was added to the family income, the total amount available for the family was ₱1,457.14. This gave to each member, which numbered 5.6 in each household, the sum of ₱260.20. The amount available for each member, according to tenure, was as follows: owner, ₱299.08; part-owner, ₱188.56; tenant, ₱178.93; cash renter, ₱187.67.

Of the various factors affecting labor earnings, crop area proved to be the most important. There was a decided increase in the operator's labor earnings as the crop area increased. The area in tobacco was also directly related to the operator's labor earnings. The tobacco crop index showed a slight influence on labor earnings. This was because tobacco was only one of the crops grown.

The total cost of producing tobacco on a hectare was ₱364.64, or ₱12.26 for each pardo, the average yield of a hectare being 33.75 pardos.

The value of production, at ₱14.00 a pardo, amounted to ₱420.80 a hectare. The net gain was ₱56.16 a hectare.

Of the total cost of production, 83.2 per cent was the cost of man labor. Tobacco growing involves much human labor.

A total of 151.77 days of man labor and 36.6 days of animal labor was needed to grow, harvest, and cure one hectare of tobacco. The operations that required large amount of man labor were the following: land preparation, 29.1 days; transplanting, 12.2; cultivation and weeding, 12.1; worming, 17.1; topping and suckering, 10.3; harvesting and poling, 26.3; classifying and poling, 30.0; curing and fermenting, 10.0. Much of the labor was needed in the months of February, March, and April. The seasonal distribution of man labor on each hectare was as follows: November, 21.5; December, 13.4; January, 12.0; February, 32.2; March, 32.7; April, 22.8; and May, 4.6.

More than a dozen varieties of tobacco were grown. The most common variety was the Espada, which was grown on 58.7 per cent of the farms. The average number of plowing was 3; of harrowing, 3. The distance of planting ranged from 80 × 80 centimeters to 100 × 100 centimeters. Farmers controlled pests by handpicking. No insecticides were used. The method of harvesting employed was priming. Curing of the leaves was done in the sun and later in the shade. Although all farmers employed crop rotation, only 51.8 per cent of the farmers grew legumes in rotation with tobacco and corn. One farmer employed green manuring. None applied commercial fertilizers.

Social conditions

The most common type of household consisted of the husband, wife, and two children. This group comprised 12.4 per cent of the 305 households. The other important types of household and the corresponding percentages were as follows: husband-wife-children-relatives, 12.7 per cent; husband (or wife)-children, 4.6; husband-wife-relatives, 4.2; husband-wife, 3.9; brothers-sisters-others, 3.2.

The number of individuals in the household ranged from 2 to 12, or an average of 5.6. Most households had 3 to 7 members. Households with four members were the most common, comprising 17.7 per cent of the total. There was only a slight difference in size of household among the different types of operators. According to tenure, the number of individuals in the household was as follows: owner, 5.6; part-owner, 5.8; tenant, 5.4; cash renter, 6.

Of the 1,705 individuals in the households, 59.2 per cent were sons and daughters of the farm operators. Only 6.5 per cent consisted of relatives and other individuals. The parents comprised 34.3 per cent. About 77.3 per cent of the households contained resident family members only and 19.3 per cent, resident family members with relatives.

Only 6.4 per cent of the houses surveyed had galvanized iron roof, wooden wall, and wooden floor. All these belonged to the owner-operators. The most common type of house had cogon roof, boho wall, and bamboo floor. This type comprised 68.9 per cent of all the dwellings studied.

The average floor area of dwellings was 39.4 square meters, or about 7.1 square meters for each person. The owner-operators had much bigger floor area than the other types of operators, the area being 42.6 square meters. The dwellings of the tenants had the smallest floor area, the average being 28.9 square meters.

There was, on the average, 2.4 rooms in a dwelling. This gave an average of 1.3 persons in a room. The owner-operators' dwellings had slightly more rooms than the part-owners' or the tenants'.

The value of dwellings ranged from less than ₱100 to more than ₱3,000. The average value was ₱606.72. In view of the larger size and better materials of construction, the value of the owner-operators' dwellings was higher than that of the other types of farm operators. According to tenure, the average value of each dwelling was as follows: owner, ₱773.05; part-owner, ₱519.04; tenant, ₱234.54; cash renter, ₱250.37.

The farm homes of these tobacco growers had limited modern facilities and conveniences. No home was provided with electric light, running water, kerosene stove, radio, or piano. Only 5.6 per cent of the homes were provided with ground wells. About 28.5 per cent of the homes had water container with faucet. The household items commonly found were: wooden chair, 40.6 per cent; iron chair, 24.8; rattan chair, 10.2; wooden bench, 11.5; wooden bed, 19.3; bamboo bed, 8.8; iron bed, 5.2; dining table, 49.2; sewing machine, 31.1. There were several musical instruments, such as the guitar, violin, and banjo. Only 1.9 per cent of the homes had phonograph.

Some of these farm dwellers exerted efforts to beautify their homes and homeground. About 34.4 per cent had potted plants in the house; 11.1 per cent, climbing plants around the house; 18 per cent, hedges on front boundaries of the yard; 3.3 per cent, hedges along side boundaries; 11.1 per cent, hedges along the walk to the stairs. Only 6.6 per cent planted hedges around the house. The number of farms with plantings of ornamental and flowering plants in the yard was 24.2 per cent. Only 4.3 per cent had potted plants in the yard.

Of the 333 sons and daughters of ages 7 to 14 years, only 75.3 per cent were in school. The percentage of school attendance was 38.1 for sons and daughters 15 to 19 years old, and 9.0 for children 20 to 24 years old.

The average grade completed by those 7 to 14 years old was 1.85; of those 15 to 24 years, 5.7.

There was a dearth of reading matter in the homes. Only 1.3 per cent had books, exclusive of school textbooks. Nearly one-half, or 46.9 per cent

of the homes, had no reading matter of any kind. *Bannawag*, which was the common magazine in the region, was found in 34.1 per cent of the homes. In 13.1 per cent, other magazines were found. Only 4.5 per cent of the homes had newspapers.

The most common recreation of farm operators were fishing, cock-fighting, hunting, and playing cards. Those of the wives were visiting friends and sewing. Among boys ten years or over, the most common recreational activities were swimming, playing coins, dancing, visiting friends, fishing, and playing ball games and musical instruments. Girls of the same age spent their leisure time in visiting friends, singing, dancing, sewing, and playing games, such as "siki".

There were seven organizations to which members of the families had membership affiliation. The most popular was the Parents-Teachers Association among the adults. The younger people belonged to a number of social and youth organizations.

SUMMARY

1. Only 33.2 per cent of the 305 farm operators were born in the municipality where they were residing. About one-half, or 49.2 per cent, were born outside the province of Isabela.

2. The owner-operators comprised 65.2 per cent; tenant-operators, 20.0 per cent. Of the amount invested in farms, 94.8 per cent was owned by the farm operators.

3. The average size of farm was 5.77 hectares, of which 2.83 were planted to crops. The area planted to tobacco averaged 1.17 hectares a farm. Corn and rice were the other important crops grown.

4. Carabao and cattle were the important work animals, the average number on each farm being 2.02 and 0.40, respectively. Swine raising was also common. The average number of pigs on a farm was 3.54.

5. The farm receipts averaged ₱1,063.54; farm expenses, ₱530.06; labor income, ₱383.46; farm privileges, ₱638.72; labor earnings, ₱1,022.18; family income, ₱1,307.12; amount available for family living, ₱1,457.14.

6. Crop area and area planted to tobacco were two important factors directly related to operator's labor earnings.

7. The cost of producing tobacco on a hectare amounted to ₱364.64, or ₱12.26 a pardo. The average yield was 33.75 pardos. The value of production was ₱420.80.

8. A total of 151.77 days of man labor and 36.6 days of animal labor was needed to grow, harvest, and cure one hectare of tobacco.

9. The most common type of house had cogon roof, boho wall, and bamboo floor.

10. The number of individuals in the households ranged from 2 to 12, or an average of 5.6.

11. Modern home facilities and conveniences were generally lacking.

12. There was a dearth of reading matter in the homes; about one-half of the homes had no reading matter of any kind.

TABLE 1
Economic conditions

	NUMBER OR AMOUNT	PERCENTAGE
Ownership of farms:		
Owner.....	199	65.2
Part-owner.....	41	13.5
Share tenant.....	61	20.0
Cash renter.....	4	1.3
Capital investment on a farm, pesos.....	2,860.67	
Capital owned by operator, pesos.....	2,711.92	94.8
Type of farm:		
Tobacco.....	173	56.7
Tobacco-corn.....	87	28.5
Tobacco-sugar cane.....	10	3.3
Tobacco-rice.....	7	2.3
Others.....	28	9.2
Average size of farm, hectares.....	5.77	
Utilization of farm area on a farm, hectares:		
Crops.....	2.83	48.6
Pasture, idle land, woodland.....	2.57	44.9
Farmstead, garden, orchard.....	0.37	6.5
Receipts from principal crops, pesos:		
Tobacco.....	445.63	48.3
Corn.....	238.53	25.8
Rice.....	101.58	12.2
Farm receipts from a farm, pesos.....	1,063.54	
Farm expenses for a farm, pesos.....	530.06	
Labor income from a farm, pesos.....	383.46	
Farm privileges, pesos.....	638.72	
Family income in pesos:		
Operator's labor earnings from the farm.....	1,022.18	78.4
Operator's income from job off farm.....	28.77	2.2
Income of other members of the family.....	230.43	17.6
Income from other sources.....	25.74	1.8
Total.....	1,307.12	100.0
Amount available for family living, pesos.....	1,457.14	
Yield of a hectare, pardos.....	33.75	
Cost of production of a pardo, pesos.....	12.26	
Cost of production of a hectare, pesos.....	364.64	
Value of production of a hectare, pesos.....	420.80	
Net gain from a hectare, pesos.....	56.16	
Man labor requirement for a hectare, days.....	151.77	
Animal labor requirement for a hectare, days.....	36.6	

TABLE 2
Social conditions

	NUMBER OR AMOUNT	PERCENTAGE
Average age of farm operators.....	44.2	
Operators born:		
In the barrio where residing.....	62	20.3
In the municipality.....	102	33.2
In the province.....	155	50.8
Length of residence:		
In the barrio, years.....	25.3	
In the municipality, years.....	26.3	
Years of experience in tobacco growing.....	18.7	
Households with resident family members only.....	240	78.7
Households containing resident family with relatives.....	55	19.3
Number of individuals in the household.....	5.6	
Dwellings with cogon roof, boho wall, bamboo floor.....	216	68.9
Dwellings with iron roof, wooden wall, wooden floor.....	12	6.4
Floor area of dwelling, square meters.....	39.4	
Number of rooms in a dwelling.....	2.4	
Number of dwellings with home conveniences:		
Sewing machine.....	95	31.1
Iron, wooden or bamboo beds.....	102	33.3
Electric light, kerosene stove, running water, radio.....	0	0
Well in farmstead.....	17	5.6
Proportion of children in school:		
7 — 14.....	251	75.3
15 — 19.....	69	38.1
20 — 24.....	10	9.0
Number of homes with:		
Books.....	4	1.3
<i>Bannawag</i>	104	34.1
Magazines other than <i>Bannawag</i>	40	13.1
Newspapers.....	14	4.6
Without any reading matter.....	143	46.9

A TRIAL CULTURE OF ALFALFA¹

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Several attempts have been made to introduce alfalfa (*Medicago sativa* Linn.) into the Philippines. In the report of the Bureau of Agriculture for 1908, Nesom (1909) stated that alfalfa, generally promising for a short period, had always failed. Experiments in Manila and elsewhere in the Philippines had encouraging results during the dry season but failed upon the advent of wet weather. In acclimatization tests of alfalfa in the College, Elayda (1919) found that a good crop can be produced where soil conditions are unusually good even if the climatic factors are less favorable. Elayda obtained seeds but did not determine the yield of forage.

In a later experiment at the College, Goseco² observed that November is the best time for planting alfalfa because the weather conditions are favorable for the growth of the plant, and they escape the attack of a serious pest, *Ceratia similis* (Olivier). Goseco also confirmed the report that poorly drained acid soils are not fit for alfalfa and that inoculation of the soil is essential.

The writers undertook this study to determine the yield of forage (a) when alfalfa was planted in Los Baños clay loam; (b) when ammonium sulfate was added to Los Baños clay loam, and (c) when lime and ammonium sulfate were added to Los Baños clay loam. The work was conducted at the College of Agriculture, Los Baños, Laguna, from November, 1946, to September, 1947.

EXPERIMENTS, RESULTS, AND DISCUSSION

Four varieties of alfalfa, namely, Ranger, Buffalo, Kansas, and an unknown variety were planted in the dry season. These varieties were received from the Kansas Agricultural Experiment Station, Manhattan, Kansas, U.S.A., on November 12, 1946. By their appearance, the seeds had been in storage for a long time.

One hundred and sixty 1-gallon cans with clay loam soil were divided into four lots of forty cans each, and each lot was further subdivided into groups of ten cans. The first ten cans of each lot were used as control; they

¹ Experiment Station Contribution No. 1535. Prepared from the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1947. Conducted in the Department of Agronomy under the direction of the senior author.

² GOSECO, FEDERICO P. Some factors affecting the growth of alfalfa in the Philippines. (Thesis presented for graduation with the degree of Bachelor of Agriculture, 1925. Unpublished.)

received no treatment. To each of the second lot of ten cans, 0.3 gram of ammonium sulfate containing 21 per cent nitrogen was added when the plants were one month old. This rate of application corresponded to 200 kilograms of ammonium sulfate to the hectare. To the third ten, chemically pure calcium oxide was added, prior to seeding time, at the rate of 3.5 grams to the can, or 2,370 kilograms to the hectare. To the fourth lot of ten cans, 0.3 gram of lime and 3.5 grams of ammonium sulfate were added.

A culture of the root-nodule bacteria of alfalfa obtained from the Bureau of Science, Manila, on October 26, 1946, was mixed with about 100 cc. of water and the seeds of the four varieties of alfalfa immersed in the bacterial suspensions.

The seeds were planted in the prepared cans immediately after inoculation. Inoculated seeds of the four varieties were also planted in plots for observation on flowering, production of seeds, and nodule formation. The plots and the cans were treated in the same manner.

The seeds were planted on December 4, 1946. They germinated on December 6, or two days after planting. The seeds had poor viability: Ranger had only 8 per cent germination; Buffalo, 14; Kansas, 24; and the unknown variety, 64 per cent. All failed to germinate in the wet season.

The seedlings were thinned to five in each can one week after germination.

Watering was done at a uniform rate and as often as necessary. Weeds were removed by hand and the pests were controlled by dusting with lead arsenate.

The height of the tallest plant in each can was measured from the base to the tip of the plant. The green weight of the tops clipped at the base about two and a half centimeters from the surface of the soil was taken.

For the wet-season culture, three other varieties, namely, Cornbelt, Mid-western, and Northern were planted on June 3, 1947. These varieties were received from the Berry Seed Company, Clarinda, Iowa, U.S.A., on June 1, 1947. The seedlings emerged on June 5, 1947, with high percentages of germination.

The plants grew fast but they tended to lodge, especially in the wet season. When dry weather set in, however, the plants hardened. The dark-green leaves developed luxuriantly, but heavy rains injured the crop; the leaves near the base of the plants rotted and the yield of forage decreased considerably.

During the first two months of growth, there were no visible differences in vegetative characters of the plants, which could be attributed to soil treatments either in the dry- or in the wet-season planting. The effects of the different applications began to appear in the third month. The leaves of the control and lime-treated plants started to turn yellow, and the rate

of growth became slower than those of the other treatments. The plants treated with ammonium sulfate and with lime and ammonium sulfate continued to develop vigorously and retained their green color. They had more branches and thicker foliage than the control and the lime-treated plants.

Only seven plants out of a total of 800, or 0.875 per cent, of the dry-season culture, and one plant out of the 640 plants, or 0.156 per cent of the wet-season planting, produced flowers. In the dry-season planting on soil treated with lime and ammonium sulfate, two plants flowered in the first ratoon, four in the second, and two in the third. Two plants on soil with ammonium sulfate and one plant on soil with lime also flowered. Ranger produced seven flowers; Buffalo, five; and Kansas, three. The unknown variety did not flower. In the wet-season planting, only Northern flowered on the soil fertilized with lime and ammonium sulfate. The flowers, however, dried up and dropped off without forming pods.

In the United States, Blinn (1920) reported that alfalfa seed production requires continuous dry weather and warm temperature throughout the growing period, and for maximum results a thin uniform stand of about one plant to two square feet of soil is necessary. Under conditions obtaining in Los Baños, there is a great deal of fluctuation of rainfall and temperature even in the dry season. Goseco³ ascribed the failure of alfalfa to set seeds to heavy rains and to the absence of pollinating bees. In this work, the writers did not observe any bees visiting the alfalfa flowers.

Although the seeds had been inoculated with the *Rhizobium* culture of "alfalfa bacteria" from the Bureau of Science, more than 50 plants did not show root nodules.

The squash beetle, *Ceratia similis* Olivier, and caterpillars of *Orgyia postica* Walker attacked the plants, but the damage was negligible. The pests were controlled by dusting with lead arsenate. No diseases were observed.

The forage from the dry-season culture was harvested on March 5, 1947, and that from the wet-season planting, on September 3, 1947, or 91 days after planting. The first ratoon crop of the dry-season planting was cut on April 11, 1947, or 37 days after the preceding harvest, and the second ratoon on May 18, 1947, also 37 days after the first ratoon was cut.

There were significant differences in the height of the plants due to treatments and to varieties in the dry-season crop. The differences, however, were insignificant in the wet-season crop. The soil treated with lime and ammonium sulfate produced the tallest plants, followed by that fertilized with ammonium sulfate alone. There was no significant difference

³ Ibid.

in height of the plants in these two treatments. Likewise, the control and the lime-treated plants did not vary significantly in height.

The significant increase in height of plants on soil treated with lime and ammonium sulfate or ammonium sulfate alone over the control and the lime-treated plants may be attributed to nitrogen, inasmuch as the bacteria used for inoculation were either dead or too weak owing to involution or degeneration in culture. The insignificant difference in height of plants in the wet-season crop was due possibly in part to the partial leaching of ammonium sulfate by heavy rains.

There were no significant differences in height of plants in the dry-season culture. However, Ranger produced significantly taller plants than Kansas in the control and Buffalo in the ammonium-sulfate-treated soil.

Ammonium sulfate, applied either alone or with lime, produced taller plants than either lime or the control. These differences in height were significant in Kansas and the unknown variety in the first ratoon. Among the varieties the differences in height under all treatments were insignificant.

As in the first ratoon crop, the height of the plants of the different varieties under all the treatments did not vary significantly.

The average yields of forage from each of five plants of the dry-season and the wet-season plant crops showed significant increases when lime and ammonium sulfate were added to the soil, either separately or together. The combination of lime and ammonium sulfate gave significantly higher yields than either of the two compounds alone. Because the nodule bacteria did not thrive, the addition of the nitrogen to the soil resulted in a marked increase in height of plants and in yield of forage. The lime applied with ammonium sulfate caused significantly higher yields of forage than ammonium sulfate alone, and the lime-treated plants produced more forage than the control. Goseco⁴ showed that alfalfa will not do well in acid soil, and Burlison, Heusinkveld, and Sears (1942) noted that alfalfa takes up a great deal of calcium from the soil and requires correction of soil acidity for proper development of its root system and of the nodule bacteria.

In the control dry-season plant crop the differences in yield of forage among the varieties were highly significant. The varieties in the descending order of their yields were: Buffalo, the unknown variety, Ranger, and Kansas. In the lime and ammonium sulfate treatment, however, where differences in yield among varieties were also significant, Kansas yielded the most and the unknown variety the least. Ranger and Buffalo gave almost the same yield. There were no significant differences in yield among the varieties in the lime and in the ammonium sulfate treatments. Similarly, in the wet-season plant crop there was no significant variation in yield due to varieties, except in the ammonium sulfate treatment.

⁴ Ibid.

In the first ratoon crop of the dry-season culture, the yields of forage were highly significant in favor of the lime and ammonium sulfate mixture. The plants fertilized with ammonium sulfate yielded more than those treated with lime. The control plants gave the lowest yields. In general, the yields of the first ratoon crop were less than one-half those of the plant crop in all the treatments. The differences in yield among the varieties were insignificant, with the exception of those in soil treated with a combination of lime and ammonium sulfate, where Kansas yielded significantly more forage than either Buffalo or the unknown variety.

Like the plant and the first ratoon crops, the second ratoon crop of the dry-season culture produced its best yields in the lime and ammonium sulfate treatments. The yields in the lime treatment and in the ammonium sulfate treatment did not vary significantly. There were no significant differences in yield among the varieties, except in the control where Ranger significantly yielded more than either Kansas or the unknown variety.

Dead plants

Plants of the dry-season culture began to die after the second ratoon crop had been harvested. The greatest number of dead plants was noted in the ammonium-sulfate-treated soil and the smallest number in the lime-treated soil. The plants treated with a combination of lime and ammonium sulfate had less dead plants than the control. The large number of dead plants in the ammonium-sulfate-treated soil was perhaps partly due to the residual effect of the acid; the smaller number of dead plants in limed soil, to the correction of soil acidity.

SUMMARY

1. The forages from the alfalfa varieties Ranger, Buffalo, Kansas, and an unknown variety, planted in the dry-season, and from Cornbelt, Mid-western, and Northern in the wet-season were ready for harvest 91 days after the seeds were planted. The ratoon crops were ready for harvest 37 days after the preceding harvest.

2. Flowers were very sparsely produced. The application of lime and ammonium sulfate to the clay-loam soil seemed to enhance the production of flowers. However, no pods were set even with the aid of mechanical tripping.

3. Plants grown in pots treated with lime and ammonium sulfate produced the tallest plants and the highest yield of forage in the dry- and wet-season plantings. Those treated with ammonium sulfate alone had taller plants and yielded more forage than those treated with lime. The control produced the shortest plants and the least forage.

4. In general, the plant crop and the ratoon of either season showed no significant differences in height of plants and in yield of forage among the varieties under the different treatments.

5. The first ratoon crop of the dry-season culture was similar to the plant crop in height of plants and in yield of forage. The highest yields in the second ratoon crop were also from pots treated with lime and ammonium sulfate. The yields of the pots treated either with lime or ammonium sulfate alone did not differ significantly.

6. The largest number of dead plants was found in soil treated with ammonium sulfate; the lowest, in limed soil.

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A STUDY OF RURAL HOUSING CONDITIONS OF ONE HUNDRED FAMILIES IN AÑGONO, RIZAL¹

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A study of the rural housing conditions in Añgono, Rizal Province, was begun in October, 1947, and the collection of data was completed in June, 1948. The major portion of the field work was conducted during December, 1947, and the data were analyzed and tabulated in the Department of Agricultural Engineering.

In regard to housing conditions, Ashby (1934) stated that a satisfactory farmhouse should provide needed working areas, storage space, and living and sleeping quarters.

Carter (1938) in Arkansas reported that about 70 per cent of the group of houses were built without definite planning so that many contained excess area. It is evident that more detailed planning would have resulted in a better design for space. The average house size was 4.68 rooms, and the average occupancy was 3.8 persons to every house. There were slightly more than two bedrooms in a house and 1.7 persons for every sleeping room. The four-room house size was the most common, and three-fourths of the houses studied had four, five or six rooms. The average house area was 961 square feet (89.3 square meters), and the average volume was about 14,000 cubic feet (396.7 cubic meters). The average annual income for the cases studied was \$785 (₱1,570), with a median income of \$550 (₱1,100). Carter found that as the annual income increased, the house size increased. There were, however, more houses above medium size. A positive correlation of 0.30 was found between family size and house size. The houses were much more mechanically equipped.

Wicker (1942) stated that it is poor economy to spend too little on the house. Good construction costs more but lasts longer; poor construction depreciates rapidly and increases upkeep cost.

Sacay and Naanep (1940) studied a farm village in Ilocos Norte, Philippines, and found that 83.8 per cent of the houses had cogon roofs and bamboo walls and floors. Only 9.5 per cent had galvanized iron roofs and wooden walls and floors. No house was roofed with nipa. The average floor area was 48.98 square meters, or 9.74 square meters for every person.

¹ Experiment Station Contribution No. 1536. Thesis presented by the junior author for graduation, with the degree of Bachelor of Science in Agriculture from the College of Agriculture, October, 1948. Prepared in the Department of Agricultural Engineering under the direction of the senior author.

There were 2.65 rooms to a dwelling, or 1.89 persons in a room. About 64.8 per cent of the dwellings had three rooms and 27.7 per cent, two rooms. The average value of dwellings was ₱136.08. About 52.2 per cent of the dwellings were valued at less than ₱100.00. The average family income was ₱241.28. Fernandez² (1947) studied the post-war conditions of tobacco farmers in San Mateo, Isabela, to supplement the data collected before the war, and found an average family income of ₱1,225.08. Most of the houses had cogon roofs, boho walls, and bamboo floors. The average number of rooms to a dwelling was 2.3. The average floor area of each dwelling was 36.0 square meters and the floor area of a person was 6.1 square meters. The average value of dwellings was ₱829.83. These Filipino authors found that the home conveniences were meager, and beautification of the home received very little attention.

MATERIALS AND METHODS

The writers studied 100 farm houses in the town of Añgono, Rizal. The information was secured by inspection and by personal interview with farmers, their wives, and their children.

RESULTS AND DISCUSSION

Añgono, formerly a barrio of the town of Binañgonan, province of Rizal, was proclaimed an independent municipality by the late President Manuel L. Quezon on August 19, 1940, through Executive Order 158. Añgono is located about 20 kilometers southeast of the city of Manila and within half a kilometer of the north shore of Laguna de Bay. The town is somewhat hilly and the streets run downhill toward the lake. The provincial road of Rizal passes through the town. The greater portion of Añgono is a part of a private hacienda. There were only 125 farms. According to the Philippine census of 1939, Añgono had an approximate farm area of 345.71 hectares, 270.72 of which were cultivated. The reported population was 3,896. Fishing is the main industry of the people and farming, next. Rice is the principal crop.

Twenty per cent of the farm operators owned the farms they tilled; 64 per cent were part owners; and 16 per cent were tenants.

The size of farms ranged from 0.20 hectare to 16 hectares. The average area of farmer-owned farms was 4.26 hectares; of part-owned, 2.23 hectares; and of tenant-farmers, 1.65 hectares. The most common size of farm ranged from 1 hectare to 2.99 hectares, which comprised more than three-fifths of the whole group. The average area of all farms was 2.54 hectares.

The average number of rooms in a dwelling was 3.29; the average number of persons to a dwelling, 5.8; the average number of persons to a

² FERNANDEZ, GREGORIO C. An economic and social study of tobacco farmers in San Mateo, Isabela. (Thesis presented for graduation from the College of Agriculture, 1947. Unpublished.)

room, 1.76; and the part of the room for a person, 0.56. The average floor area of dwellings was 40.86 square meters; the average floor area for every room, 12.38 square meters; and the floor area for a person, 6.95 square meters. There was no indication that this group of houses was built to provide sleeping rooms or bedrooms exclusively according to the number of persons in the family. The 184 sleeping rooms found in this survey were used either for dual purposes as living room-bedrooms and dining room-bedrooms or as bedrooms only. A total of 588 persons lived in the one hundred homes surveyed, or an average of 3.2 persons to a sleeping room. In general, the 2- and 3-room houses had one or two living room-bedrooms; the 4-room houses usually had two living room-bedrooms, although in some cases there was a separate bedroom; and the 5- or 6-room houses were planned with two bedrooms and a dining room-bedroom. Most of the houses, or 80 per cent, did not have separate dining rooms; a room usually served both as kitchen and dining room.

Plans, construction, materials used, cost and present value

Of the 100 houses studied, 89 per cent were built with plans prepared by the house owners; only 7 per cent were constructed with plans prepared by individuals like an architect, a carpenter, or a neighbor; and 4 per cent were built with plans obtained from magazines and other periodicals.

Nearness to school, church, and neighbors had an important social influence on the location of the farmhouse. Sources of water supply determined also the location of the farmhouse. Houses constructed near the road were within a short distance from artesian wells and ground wells. Natural features, such as contours and landscape effects, were unknown to these farmers. Most of their dwellings were located on level land. Dwellings located on heavy clay loam soil were improperly drained during rainy days, though 63 per cent of the houses which were built on light porous soil were well drained.

Ten per cent of the houses were of galvanized iron roofs, wooden walls, and wooden floors; 17 per cent had nipa or cogon roofs, nipa, cogon, bamboo or boho walls, and bamboo floors; and 73 per cent were of mixed materials. The hip³-roof type which comprised 94 per cent was the most popular; the gable-roof type was only 6 per cent. In most cases, the shed roof was used only for the porch and kitchen. About 55 per cent of the houses were built with front porch, and 76 per cent with rear porch or *batalan*. In sixteen houses the *batalan* was used to keep kitchen accessories, or as the kitchen itself. About 89 per cent of the houses were built by carpenters and 11 per cent by the family members. All the houses were one-story type without ground floor. Only seven of the houses were painted. About 84 per cent of the houses were built with their long axis along the

³ The hip roof slopes to all four walls from the shortridge center.

north-south direction; 13 per cent, along the east-west; and 3 per cent, along the northwest-southeast. The direction of the prevailing winds is usually from the first quadrant, that is, from east-northeast to north-northeast directions striking the front or rear portion of the houses. Other winds are only occasional.

In 46 per cent of the houses, mixed materials of galvanized iron and nipa were used as roof in the different rooms. About 37 per cent had entirely galvanized iron roofing, and only 17 per cent used either nipa or cogon.

Forty-eight per cent of the houses had wooden exterior walls. Nipa was used in 34 per cent and in the rest, a mixture of wood, bamboo, nipa, and galvanized iron for exterior walls of the different rooms. Only three houses had exterior walls of boho and bamboo.

Wood was the most typical material for partitions in 42 per cent of the houses. Mixed materials of wood and bamboo in different rooms were used in 19 per cent, and bamboo in about 39 per cent.

Almost 75 per cent of the houses had bamboo floors; only 10 per cent, wood; and about 15 per cent, wood and bamboo in the different rooms.

Almost all of the dwellings used wood for posts. Bamboo posts were used only for short supports.

Only one case had concrete stairs; 16 per cent, a combination of wood and concrete; 38 per cent, bamboo; and 45 per cent, wood.

Window shutters made of sash were used in more than 50 per cent; only 29 per cent were of *sawali*, 14 per cent of wood, and the rest of either wood and bamboo or wood and nipa.

About 96 of the houses had door shutters. Of the materials used for door shutters, all wood was used in 55.2 per cent, and a mixture of wood and bamboo with wood as the frame in 38.5 per cent.

Only 25 of the houses had ceilings, 17 of which were of wood, 7 of boho, and 1 of *sawali*.

Of the 70 houses with post footings or foundations, 45 had stone and 25, concrete foundation. Thirty of the house owners did not bother to provide foundation for their homes; they had posts stuck into the ground. This was the most unsatisfactory structural feature.

Almost all of the houses included in this survey were built during the period 1923-1942. More than three-fifths of the houses were built from 1934 to 1940. The construction cost of dwellings ranged from less than ₱100.00 to more than ₱1,000.00, or an average of ₱435.20. The most common cost of construction ranged from ₱101.00 to ₱200.00. The average floor area and number of rooms were 31.90 square meters and 2.91 rooms, respectively.

The value of the dwellings in 1947-1948 was twice the construction cost in spite of its depreciation. This was so because the purchasing value

of money during this period was lower than that before the outbreak of the war. The cost of repair and improvements had also increased the value of the dwellings. Such value ranged from less than ₱500.00 to more than ₱4,500.00, or an average of ₱808.25. About one-half of the houses had an average value of ₱292.21.

House and family size characteristics

The number of individuals in the household ranged from 2 to 10. About four-fifths of the families had 5 to 8 members. Twenty-seven per cent of the households had 5 members to a family. The average family size was 5.8 persons. About 32.1 per cent were parents, 60.4 per cent were children, and 7.1 were relatives. Other persons who were not related to the family constituted only 0.4 per cent. Of the 588 individuals, 52.2 per cent were males and 47.8 were females.

The average number of rooms to a dwelling was 3.29, with an average floor area of 40.86 square meters. About 52 per cent of the houses had 3 rooms with an average floor area of 36.53 square meters, the most common house size.

A slight relationship existed between family size and house size. There was generally a slight increase in house size as family size increased, although there were cases where houses were below average size while the family was above average size or vice versa. An increase in the number of rooms did not always increase the floor area; in some cases the floor area decreased. This practice of building houses irrespective of family size results, in part, to crowded or inadequate housing conditions. Financial resources also affect the size of houses. Analyses indicated a correlation of +.41, showing a slight increase in house size as family size increased.

Family income and size of family house

Fifty-eight per cent of the entire income groups had an income range of ₱501-₱1000, the most common range. The average family income was ₱1,292.25.

The house size increased as income increased from 2.25 rooms with a floor area of 24.33 square meters at the lowest income level, to 5 rooms with a floor area of 83.97 at the highest income level. In some cases, there was a decrease in house size in spite of an increased income, and some families with a much less income than the others had built larger houses. Analyses indicated a correlation of +.62, which shows some relationship between house size and family income.

Household facilities and conveniences

The modern facilities and conveniences were generally lacking in rural houses. There was no running water in all of the houses, and only two homes had lift pumps. Less than one-half of the total number of homes

used electric lights, while the rest used kerosene lamps. Only one home had a gas stove, an ice box, and some electrical appliances. Five per cent of the dwellings had radios, and about 30 per cent had sewing machines. Wooden and bamboo benches; wooden, bamboo, and steel chairs; wooden tables and wardrobes or *aparadors* were the most common furniture in the homes.

Homeground beautification

The interest among country dwellers in beautifying their homes was generally lacking. There were very few cases where attempts were made to beautify their homes, although potted plants were common in more than one-half of the number of houses surveyed.

Sanitation

Only 52 homes had outdoor toilets and 4 had indoor toilets. Indoor toilets employed the *pail system* because of the absence of running water in the house. About 63 per cent of the dwellings were well drained because they were located on light porous soil. The sources of drinking water were the artesian well, 92 per cent; ground well, 6 per cent; and stream, 2 per cent. Drinking water from the open ground well and stream was obviously exposed to dangerous contamination. About 85 per cent of the homes had drinking water containers with faucets.

Different outbuildings

There were only 34 outbuildings, 21 of which were poultry houses, 10 were granaries, and 3 were implement sheds, which were often used also as resthouses. Most of the farmers used big baskets or *bugsok* made of boho for rice storage. Of the 21 poultry houses, only 2 were for chickens and 19 for ducks. There were neither barns nor hog houses in this locality. Carabaos were placed in corrals at night and were allowed to graze in the fields at daytime. Most of the pigs, chickens, ducks, and turkeys were improperly housed or not housed at all, resulting in a more insanitary and an unhealthful place both for the animals and the family members themselves. Very little effort had been done to keep these farm animals, especially the pigs, chickens, and turkeys, from roaming around. Some were kept under the house enclosed by fences, while others were fenced in the whole yard to prevent them from annoying the neighbors.

SUMMARY AND RECOMMENDATION

1. About 20 per cent of the farm operators were owners; 64 per cent, part owners; and 16 per cent, tenants.
2. The average size of farms was 2.54 hectares. The average area of owners' farm was 4.26 hectares; of part-owners', 2.23 hectares; and of tenants', 1.65 hectares.
3. The average number of rooms in a dwelling was 3.29; number of persons, 5.8; number of persons to a room, 1.76; and the space of room for a

person, 0.56. The average floor area of dwellings was 40.86 square meters and the floor area of a room, 6.95 square meters. The average number of persons in a sleeping room was 3.2.

4. About 89 per cent of the houses were constructed with owners' planning; 7 per cent, with plans made by other individuals; and 4 per cent, with plans taken from magazines and periodicals.

5. Of the one hundred homes studied, 10 per cent had galvanized iron roofs, wooden walls, and wooden floors; 17 per cent, nipa or cogon roofs, nipa, cogon, bamboo or boho walls, and bamboo floors; and 73 per cent, mixed materials. The hip-roof type, which was the most common, comprised 94 per cent; the gable roof, only 6 per cent.

6. Mixed materials of galvanized iron and nipa were the most commonly used as roof in different rooms. Wood was the most typical material used for exterior and interior walls. Almost three-fourths of the houses used bamboo for floors and wood for posts. Bamboo or wood stairs were very common. Window shutters made of sash were the most prevalent. Not all of the houses had door shutters; if any, they were usually made of wood. Only 25 houses had ceilings, 17 of wood and 8 of boho and *sawali*. Stone was the most common material for post footings or foundations. Thirty per cent of the house owners did not provide foundations for their homes. Of the 70 houses with post footings, only 25 were concrete.

7. The average prewar construction cost of dwellings was ₱435.20; the usual construction cost, however, ranged from ₱101.00 to ₱200.00.

8. The average value of dwellings at the time of this survey was ₱808.25. About one-half of the group of houses had an average value of ₱292.21.

9. The average family income was ₱1,292.25. The most common income, however, was from ₱501.00 to ₱1,000.00, which was 58 per cent of the different groups of family income.

10. A slight relationship existed between family size and house size. There was generally a slight increase in house size as family size increased.

As income increased, the house size increased from 2.25 rooms with a floor area of 24.33 square meters at the lowest income level to 5 rooms with a floor area of 83.97 square meters at the highest income level.

11. Modern facilities and conveniences were generally meager in rural houses, and interest among country dwellers in beautifying their homes was generally wanting. Potted plants in the house was the most common means of beautification.

12. Fifty-two homes had outdoor toilets and 4 had indoor toilets. About 63 per cent of the location of dwellings were well drained. For drinking water, 92 per cent used artesian well; 6 per cent, ground well; and 2 per cent, stream.

13. Most of the farm animals were improperly housed. There were only 21 poultry houses and no barns nor hog houses. Of the 34 outbuildings, 10 were granaries and 3 were implement sheds or resthouses. Most farmers used big baskets (*bugsok*) for rice storage.

14. It is recommended that a basic farm house, based on the average housing condition of the locality, should consider the following:

Number of persons in a room.....	1.76
Number of persons in a bedroom	3.2
Floor space for a person, in sq. m.....	6.95

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THE GRAZING CAPACITY OF PASTURES¹

CRISPIN E. CABANILLA

WITH ONE TEXT FIGURE

Grazing of animals on the pasture is a common practice in the Philippines, but the number of animals allotted on a pasture is often overlooked by the rancher. Insufficient feed results in the stunting of the animals; excess feed, in the overgrowth and overmaturity of pasture plants. Pastures have an important rôle in reducing the cost of producing cattle. The present study was conducted in the Department of Animal Husbandry from January 16, 1947, to March 5, 1948, to determine the grazing capacity of pastures for Philippine breeding cows and their calves.

Gonzalez (1920) and Villegas (1928) estimate that one hectare of pasture in the Philippines will support an ox the whole year round.

Morrison (1945) states that the area of pasture required by a head of beef cattle when fed no grain is 2 acres (.81 ha.) or less for every 1,000 pounds (454 kgm.) live weight on fertile pasture lands in humid districts. On good grazing lands of the western ranges in the United States, 7 to 10 acres (2.8 to 4.0 ha.) or more of pasture land are required. If no soiling crops or summer silage is provided for periods of drought, 1.5 acres (.6 ha.) to 2.5 acres (1.0 ha.) of fairly good pasture should be provided each dairy cow. If such additional feed is furnished and the pasture is properly fertilized, the pasture can be reduced to one acre (.4 ha.) or even less for each cow.

MATERIALS AND METHOD

Six full-grown Philippine cows, each with a calf, were used in the experiment. Two of the cows were about one and one-half years of age, two were two years, one about two and three-fourth years, and one three years.

A six-hectare pasture land was divided into half-hectare lots, each fenced with 3-strand barbed wires. One dam and her calf were assigned to one hectare throughout the year, the pasturage being rotated from one half-hectare lot to the other. Minda (dam) and Mino (calf) were assigned to lots V and VII; Maraway (dam) and Mara (calf), to lots IV and VIII; Palsara (dam) and Pala (calf), to lots I and XII; Luta (dam) and Lutana (calf), to lots II and XI; Malva (dam) and Malvo (calf), to lots VI and X; and Bonkalota (dam) and Kalota (calf), to lots III and IX.

¹ Experiment Station Contribution No. 1537. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1948. Prepared in the Department of Animal Husbandry under the direction of Professor Valente Villegas and Instructor José P. Esguerra.

The individual weights of the animals were taken at 15-day intervals throughout the experiment. Weighing was done in the afternoon after they had been driven to the watering place.

Samples of pasture plants were cut on the first day of March, May, and September, 1947, and January and March, 1948. The first sampling was taken diagonally from each lot at three different places, covering an area of four square meters each. The sampling was later limited to a smaller area to minimize the effect on the stand of forage. Seventeen samples of 25 centimeters square each were taken at cross diagonals in each lot for the subsequent samplings. The samples were cut as close as possible to the ground, placed in paper bags, and weighed immediately. They were dried to constant weight in the sun, and the percentage of air-dry weight over the given weight was determined.

During the experiment, the weeds were cut in May, July and October 1947.

The animals were allowed to graze in their respective lots as long as there was enough forage for them. When the forage plants became short (cogon, 12 centimeters, and amorseco, 7 centimeters), rotation of pastures was made. Grazing was uneven because the animals were free to choose the more palatable species and the young growth in the pasture areas.

Water was accessible to the animals throughout the investigation. Coarse salt was given to them regularly in a basin, or in the palm of the hand or on the ground. The ease with which the animals could be handled was attributed mainly to salting. The average amount of salt given to each adult animal was 109 grams a week, or 436 grams a month.

RESULTS AND DISCUSSION

The pasture land is located in a region with a mild climate. The rainfall in the year of the experiment ending January 31, 1948, was low from February to April, 1947, but heavy the rest of the year; the average was 171.25 millimeters.²

The plants in the pastures were cogon, *Imperata cylindrica* (Linn.) Beauv., var. *koenigii* (Retz.) Benth; amorseco, *Andropogon aciculatus* Retz.; kulape, *Paspalum conjugatum* Berg.; aguingay, *Rottboellia exaltata* Linn. f.; talahib, *Saccharum spontaneum* Linn. subsp. *indicum* Hack.; mutha, *Cyperus rotundus* Linn.; mani-manihan, *Desmodium capitatum* (Burn. f.) DC.; Bermuda grass, *Cynodon dactylon* (Linn.) Pers.; sabung-sabungan, *Panicum flavidum* Retz.; paragis, *Eleusine indica* (Linn.) Gaertn.; *Centrosema pubescens* Benth; *Calopogonium muconoides* Desv.; sensitive plant, *Mimosa pudica* Linn.; ipil-ipil, *Leucaena glauca* (Linn.) Benth.; spineless bamboo, *Bambusa vulgaris* Schrad.; sili-silihan, *Synedrella nodiflora* (Linn.)

² Data taken from the observation weather station of the U. P. College of Agriculture.

Gaertn.; dilang-aso, *Elephantopus spicatus* Aubl.; saluyot, *Corchorus acutangulus* Lam.; kulut-kulutan, *Triumfetta bartramia* Linn.; pasiti, *Capsicum frutescens* Linn.; sambong, *Blumea balsamifera* (Linn.) DC.; eskoba, *Sida retusa* Linn.; balatong-aso, *Cassia tora* Linn.; pongapong, *Amorphophallus campanulatus* (Roxb.) Blm.; palis, *Callicarpa cana* Linn.; panda-kaki, *Tabernaemontana pandacaqui* Poir.; aroma, *Acacia farnesiana* (Linn.) Willd.; *Lantana camara* Linn.; *Psidium guajava* Linn.; kakawate, *Gliricidia sepium* (Jacq.) Steud.; anonang, *Cordia dichotoma* Forst. f.; hauili, *Ficus hauili* Bleo.; isis, *Ficus ulmifolia* Lam.; dita, *Alstonia scholaris* (Linn.) R. Br.; acacia, *Samanea saman* (Jacq.) Merr.; and duhat, *Syzygium cumini* (Linn.) Skeels.

The distribution of grasses and weeds in the different lots follows: In lots I, II, III, V, VI, VII, and VIII, cogon was the prevalent pasture feed. With it were various other species of plants constituting less than one-fourth of the forage in the lot. These pastures may be called cogon pasture. Lots IX and X showed an even distribution of cogon, amorseco, and kulape, with sambong as the dominant weed. In lots IV, XI, and XII, amorseco was abundant, with various species of grasses and weeds of which cogon was the principal grass and sambong the chief weed. Lot IX, although fairly exposed to sunshine, was the most shaded with trees. Lots I, V, VI, VII, VIII, X, XI, and XII, had also a few shade trees. Lots III and IV had no shade trees.

The pastures had been under close grazing about two months before the animals were placed in the experimental lots. The grasses lacked vigor and were short. The yield and carrying capacity was, therefore, poor. The animals were at the time feeding on dry forage owing to shortage of pasture.

Yield of pasture plants

The average weight of fresh forage harvested from 625 square centimeters on March 1, 1947, was 38.53 grams. The yield increased to 57.11 grams on May 1, 1947; 81.34 grams on September 1, 1947; 109.05 grams on January 1, 1948; and 115.68 grams on March 1, 1948.

The computed average yield of pasture forage from one-half hectare was 3,082 kilograms on March 1, 1947; 4,569 kilograms on May 1, 1947; 6,507 kilograms on September 1, 1947; 8,724 kilograms on January 1, 1948; and 9,254 kilograms on March 1, 1948.

The average air-dry weight of forage harvested from 625 square centimeters on March 1, 1947, was 25.02 grams. The average production increased to 35.59 grams on May 1, 1947; 38.03 grams on September 1, 1947; 72.40 grams on January 1, 1948; and 77.45 grams on March 1, 1948.

The computed production of air-dry forage from each half-hectare was 2,001 kilograms on March 1, 1947; 2,847 kilograms on May 1, 1947; 3,043 kilograms on September 1, 1947; 5,791 kilograms on January 1, 1948; and 6,196 kilograms on March 1, 1948.

The relation of dry weight to fresh weight of forage was about the same except that on September 1, 1947. The forage on March 1, 1947, showed an average percentage of 64.90, that on May 1, 1947, 63.24 per cent; that on January 1, 1948, 66.39 per cent; and that of March 1, 1948, 66.80 per cent. On September 1, 1947, the average percentage was 46.75; this indicated that the forage was much more succulent.

Effect on live weight of animal

Minda (dam) fluctuated much in weight throughout the experiment. In June she lost 14.0 kilograms and in November, 11.5 kilograms, both computed from her weight the preceding month. The significant decrease in weight in June was apparently due to the laxative effect of the young, soft, and tender pasture plants. The decrease in November was probably due to the effect of the three typhoons that month. This cow gained 18 kilograms, her highest monthly increase, in August. At the end of the experiment she had gained 14.0 kilograms over her initial weight.

Mino (calf) gained in weight throughout the experiment. He made the highest gain of 16 kilograms in January. At the end of the experiment the gain over the initial weight was 104.7 kilograms.

The loss in weight of the dam in June and November was not offset by the gain in weight of the calf during the same months. However, the decrease in the combined weights was slight. Both the dam and the calf made significant gains in March, July, August, and October. At the end of the experiment both dam and calf had gained 118.7 kilograms.

Maraway (dam) lost much weight in June and November, probably due to the same cause as of Minda during the same months. At the end of the experiment Maraway had gained 19.3 kilograms over the original weight.

Mara (calf) continuously increased in weight throughout the experiment. Her highest gain of 20.5 kilograms was in August, followed by her gains in April, October, and December. At the end of the experiment her gain was 105.7 kilograms.

Both dam and calf increased markedly in weight in April, August, March, and October. The decrease in weight of the dam in November was not offset by the increase in weight of the calf. At the end of the experiment both dam and calf had gained 125.0 kilograms.

Palsara (dam) decreased heavily in weight in June and November, but slightly in May, September, and October. The highest increase in weight

was in July. The gain in weight at the end of the experiment was 16.3 kilograms.

Pala (calf) gained weight throughout the experiment, especially in the early part; her greatest gain was in May, 22 kilograms. Her total weight gain was 125.3 kilograms.

The combined weights of the dam and the calf registered a decrease in June, October, and November; the highest loss was 5 kilograms in June. Both dam and calf gained 141.6 kilograms over their combined weights at the start of the experiment.

Luta (dam) lost 16.5 kilograms in May. She also lost but much less in July, November, and December, 1947, and in February, 1948. She made, however, a gain of 21.5 kilograms at the end of the experiment.

Lutana (calf) made good gains throughout the experiment, except in March when she lost 5 kilograms. She made the highest gain, 23 kilograms, in December. At the end of the experiment, she had gained 96.5 kilograms over her first weight.

If the weights of dam and calf are combined, the decreases in weight in March and May, 1947, and in February, 1948, was not much. The highest gain was in April and September, 24.0 kilograms and 23.5 kilograms, respectively. At the end of the experiment, both had gained 118.0 kilograms over the original weight.

Malva (dam) lost weight six times during the experiment. In April the loss was due to calving. In September she made the heaviest loss of 13 kilograms. Unlike the other cows, she weighed less at the end of experiment; the loss was 10.4 kilograms.

Malvo (calf) made gains throughout. His heaviest gain was 24 kilograms in September, when loss of the dam was heaviest. The combined weights showed a decrease of 3.5 kilograms in June, but there was a gain of 102.9 kilograms at the end of the experiment.

Bonkalota (dam) lost little weight in July, September, October, December, and January. The increase in weight in August was very marked, 24.5 kilograms. At the end of the experiment she had gained 15.6 kilograms over her initial weight.

Kalota (calf) made gains throughout the experiment, except in November when she lost 8.5 kilograms. At the end of the experiment she had gained 116.0 kilograms.

The dam and calf slightly decreased in weight in July, October, and November. Both made the highest gain of 37 kilograms in August. At the end of the experiment both had gained 131.6 kilograms.

The average live weight of all the dams fluctuated throughout the experiment. Small decreases occurred in May, June, September, November,

and December. The highest increase, 11.4 kilograms, was in August. The gain over the initial weight was 12.8 kilograms.

The calves made substantial gains; the smallest gain was 4.8 kilograms in March and the highest, 13.4 kilograms in September. The gain over the initial weight was 109.8 kilograms.

The combined weights of the dams and calves registered a continuous increase. At the end of the experiment there was an average gain of 122.6 kilograms over the initial weight.

Growth and development of calves

Pala had the highest birth weight of 21.8 kilograms; followed by Lutana, 19 kilograms; Mino, 18.1 kilograms; Kalota 13.6, kilograms; Malvo, 13 kilograms; and Mara, 11.8 kilograms. The average birth weight of all calves was 16.3 kilograms. This is 2.32 kilograms lower than the 18.62 ± 0.56 kilograms found by Villegas (1939) as the mean birth weight of both sexes of the native oxen.

In two months Mara made the highest gain over her birth weight with 27.2 kilograms; Lutana, 25 kilograms; Pala, 23.2 kilograms; Malvo, 18 kilograms; and Mino, 15.9 kilograms. The average weight of all calves at this age was 37.6 kilograms; the average gain over the birth weight was 21.4 kilograms, which was 139.5 per cent of the birth weight.

Four months after birth, Pala made a gain of 32 kilograms that surpassed the increases in weight of the other animals during the two-month period. Kalota and Lutana made each a gain of 29 kilograms; Mara, 26 kilograms; Mino, 24 kilograms; and Malvo, 12 kilograms. Pala, with 77.0 kilograms, was the heaviest at this age; Malvo, with 43.0 kilograms, the lightest. The average weight of all calves was 63.0 kilograms, while the average gain was 25.8 kilograms, or 66.8 per cent of their weight at the age of two months.

At six months of age, Pala made the highest gain of 28.0 kilograms, while Mino the lowest gain of 8.0 kilograms. At this age, Pala led with a weight of 105 kilograms; followed by Lutana, 90 kilograms; Mara, 80 kilograms; Kalota, 76 kilograms; Mino, 66 kilograms; and Malvo, 65 kilograms. The average weight of all calves was 80.3 kilograms and the average gain was 17.3 kilograms. This gain was on an average 28.3 per cent of the weight at four months of age.

At eight months of age, Pala still had the heaviest weight of 116 kilograms but made the lowest gain of 11 kilograms. Malvo was the lightest, with 86 kilograms, while Mino made the highest gain of 28 kilograms. The average weight of all calves at this age was 100 kilograms and the average increase was 19.6 kilograms, which is 25.4 per cent of the weight at the age of six months.

At ten months of age, Lutana, with 137 kilograms, was the heaviest. Pala weighed 132 kilograms; Kalota, 118 kilograms; Mara, 115 kilograms; and Mino and Malvo, 108 kilograms each. The average weight was 119.6 kilograms and the average increase of all calves was 19.8 kilograms, or 19.9 per cent of the weight at eight months.

At 12 months of age, Lutana, with 145 kilograms, was the heaviest; followed by Kalota, 142 kilograms; Pala, 141 kilograms; Mara, 134 kilograms; and Mino, 133 kilograms. The average weight was 139 kilograms and the average increase of all calves was 17.0 kilograms, or 14.5 per cent of the weight at ten months of age.

Figure 1 shows graphically that the cows more or less maintained the curve from the beginning to the end of the experiment; they made a little

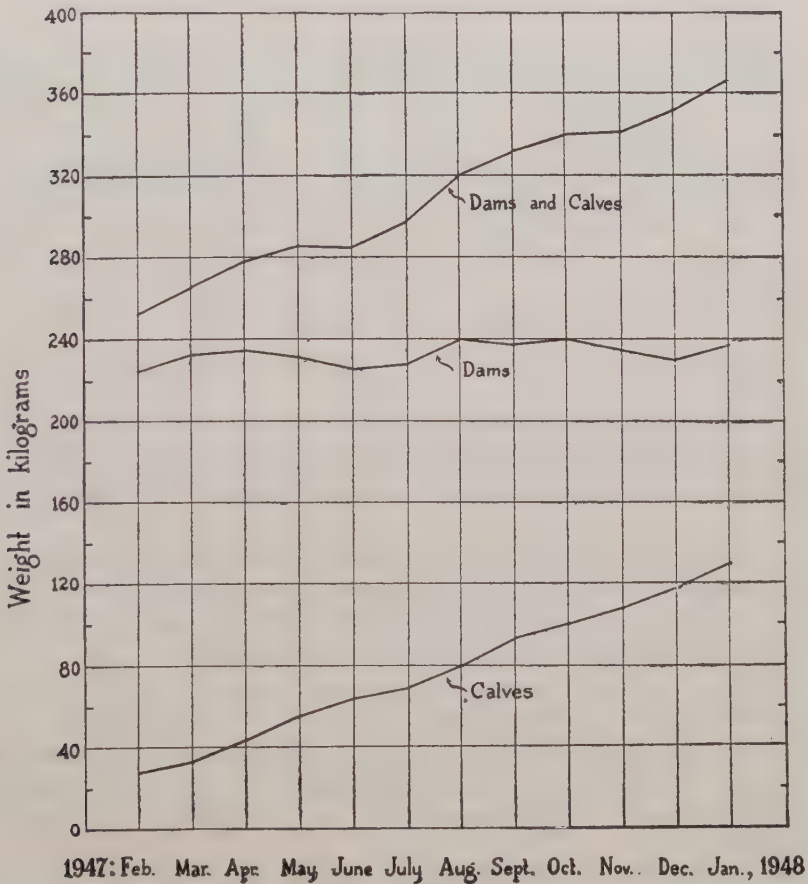


Fig. 1.—A graphic representation of the average monthly weight of the dams and calves and that of both dams and calves in the pastures.

gain over the initial weight. The weight increase of the calves rose steadily, and large gains were made towards the end of the experiment. In the dams and calves the curve also rose, though not so much as in the calves.

It was noted in this experiment that typhoons are detrimental to the animals; cows with calves, therefore, should be placed under shelter during bad weather.

Rotation of pastures

The pasture lots were rotated eight times during the course of the investigation. The first grazing period lasted two months; the first rotation was made on April 30, 1947; the second, on July 16, 1947; the third, on September 3, 1947; the fourth, on November 4, 1947; the fifth on December 3, 1947; the sixth, on January 4, 1948; the seventh, on February 3, 1948; and the last, on March 3, 1948.

Observations

In spite of the adequacy of the pastures, the dams could not maintain their weight throughout the experiment; however, the calves developed well and consistently made gains in weight. Evidently, the cows were unable to take enough feed to meet the needs of their bodies after furnishing the requirements of the calves. These results agree with the findings of Smith (1937) who reported that in swine, the young increase in weight at the expense of the nursing sow from the time of parturition to the end of the suckling period.

SUMMARY AND CONCLUSION

1. Six full-grown Philippine cows and their calves were used in the experiment.
2. Cogon, *Imperata cylindrica* (Linn.) Beauv., var *koenigii* (Retz.) Benth., and amorseco, *Andropogon aciculatus* Retz., were the principal pasture grasses. Sambong, *Blumea balsamifera* (Linn.) DC., was the dominant weed.
3. The air-dry weight of the forage constituted, on the average, 61.6 per cent of the fresh weight. The highest percentage of air-dry weight, 66.80, was from the sample cut on March 1, 1948; the sample collected on September 1, 1947, had the lowest percentage of 46.75.
4. The computed average yield of fresh forage for each half hectare was 6,427 kilograms, with an air-dry weight of 3,976 kilograms.
5. The cows showed great fluctuation in weight during the experiment. The highest monthly increase in weight among the cows, 11.4 kilograms, occurred in August. The average gain over the initial weight was 12.8 kilograms.
6. The smallest average monthly increase made by the calves was 4.8 kilograms in March; the highest increase, 13.4 kilograms in September. The average gain over the initial weight was 109.8 kilograms.

7. The combined weights of the dams and calves increased monthly throughout the experiment, except in November when there was a very insignificant decrease of 0.1 kilogram. The average gain over the initial weight was 122.6 kilograms.

8. The average weights of the calves at different ages were as follows: birth weight, 16.3 kilograms; at the age of 2 months, 37.6 kilograms; at 4 months, 63.0 kilograms; at 6 months, 80.3 kilograms; at 8 months, 100 kilograms; at 10 months, 119.6 kilograms; and at 12 months, 139 kilograms. The average gain over the birth weight of all the calves at 2 months of age was 139.5 per cent; at 4 months, 66.8 per cent of the weight at 2 months; at 6 months, 28.3 per cent of the weight at 4 months; at 8 months, 25.4 per cent of the weight at 6 months; at 10 months, 19.9 per cent of the weight at 8 months; and at 12 months, 14.5 per cent of the weight at 10 months.

9. The rotation of the pastures was made eight times during the investigation. The first grazing period lasted two months; the second, two and a half months; the third, one and a half months; the fourth, two months; and the fifth, sixth, seventh, and eighth, one month each.

10. In spite of the adequacy of the pastures, the dams could not maintain their weight during the experiment. The cows were unable to take enough feed to meet their needs after furnishing the requirements of their calves, which were making gains throughout the investigation.

11. The foregoing results tend to show that one hectare of pasture land is more than enough to support one Philippine breeding cow and her calf.

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EFFECTS OF SOIL REACTION ON THE GROWTH OF UPLAND RICE AND ON ITS NITROGEN, CALCIUM, PHOSPHORUS, AND IRON CONTENT¹

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WITH ONE TEXT FIGURE

This paper is the second article on the effects of soil reaction on the soil-plant relationship. Soil reaction is a single-value soil property capable of influencing the ability of plants to make use of the nutrients in the soil. Studies made elsewhere along this line are reported by Hoagland (1919), Truog (1930), Zimmerly (1930), Hester and Shelton (1934), and Blair, Prince, and Winterberg (1937), and in the Philippines by Arciaga and Galvez (1948).

To determine the effects of soil reaction on the growth of upland rice and on its nitrogen, calcium, phosphorus, and iron content, the present study was undertaken in the Department of Soils of this College from June, 1946, to February, 1948.

EXPERIMENTS, RESULTS, AND DISCUSSION

Soil. Medium phase Los Baños clay loam taken near the College reservoir was used in this experiment. The area where the soil was taken is slightly rolling and planted to luxuriantly growing ipil-ipil (*Leucaena glauca* Linn.). The surface soil is dark brown and about 7 inches (17.78 cm.) deep. It is moderately compact and pulverizes easily when dry but sticky and plastic when wet. According to Aristorenas (1937), the surface soil of Los Baños clay loam, medium phase, has a maximum water-holding capacity of 62 per cent, a specific gravity of 1.27, a pore space of 61 per cent, a pH of 7.38, and 0.06 per cent K₂O. Aquino and Orig (1941) reported that this soil type contains 0.0107 per cent P₂O₅, 0.0031 per cent K₂O soluble in 1 per cent citric acid, and 0.0031 per cent nitrogen.

The soil was air-dried, pulverized, screened through a 7-mm. sieve, and then thoroughly mixed. Ninety holes measuring 23.5×23.5×34.0 centimeters and 70 centimeters from each other were dug in 9 groups one meter apart. Each hole was filled with 15 kilograms of the prepared soil and treated as follows: to lots I, II, III, and IV standard sulfuric acid solution in varying amounts diluted to 4000 ml. was added, while lots V, VI,

¹ Experiment Station Contribution No. 1538. Thesis presented by the senior author for graduation with the degree of Bachelor of Science in Agriculture, from the College of Agriculture, University of the Philippines, March, 1948. Prepared in the Department of Soils under the direction of the junior author.

VII, and VIII received different amounts of lime shaken in 4 liters of water. The control lot received only 4 liters of tap water. All the lots were allowed to age for a week, after which representative samples were taken from each hole.

The pH values of the soil samples were determined colorimetrically in accordance with the technique of Bear (1942), using the LaMotte pH outfit.

The nine lots of ten replications each showed pH values ranging from 5.3 to 7.5. During the growing period of the plants, both the alkaline and acidic reactions tended to approach neutral reaction. Emmert (1931) assigns this tendency to the neutralizing action of the plants, the loss of the reagents by leaching, and the buffering action of the soil. Hoagland is cited by Emmert (1931) as stating that the plant is very effective in changing a nutrient solution from extremes of either acidity or alkalinity to very near neutrality.

The rice used. The Inintiw rice seeds used in the study were supplied by the Department of Agronomy. They had an average viability of 94 per cent. Inintiw rice is a nonbearded variety producing straw-colored and elliptical medium-sized kernels of fair eating quality. According to Calma and Palis (1948), Borja and Torres (1930) reported that this variety matured within 120 days and gave a fair yield. Calma and Palis (1948) found that Inintiw bloomed from one to three days, attained a mean height of 152.28 centimeters, and lodged before the crop was ready for harvesting.

Chlorosis was noticed among plants in the seedling stage, in lots having pH values of 7.1, 7.3, and 7.5 respectively. This may be attributed to the precipitation by the hydroxyl ion of the metallic iron, which renders it unavailable to plants. The chlorotic condition persisted till the plants were about two months old. Not until two weeks after the application of ammonium sulfate did some of the plants recover from their chlorotic condition. This improvement of the color of the plants was probably due to the acidulation of the medium, promoted by the addition of the acidic fertilizer, ammonium sulfate. The plants in the lot having pH 7.1 showed the highest stage of improvement, and those in lots with pH values of 7.3 and 7.5 remained stunted. These effects tend to show that the acidity caused by the addition of ammonium sulfate was not enough to reduce the concentration of the hydroxyl ion and adjust the acidic and basic constituents to the requirement of the plants.

The plants growing at pH 5.7 produced the greatest number of tillers, but those growing at pH 7.1, 7.3, and 7.5 hardly produced tillers. The influence of pH on panicle production showed that pH 6.2 was best for the

production of panicles, whereas pH higher than 6.9 was unfavorable. The height of the plants varied significantly; pH 5.7 was the most favorable and pH 7.5 the most unfavorable. The plants growing on the acidic soil were generally taller than those grown on the alkaline soil (fig. 1).

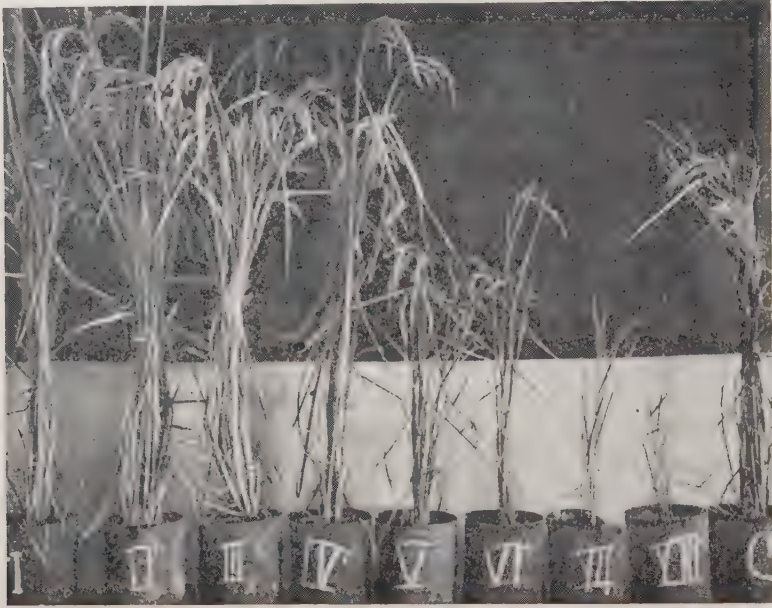


Fig. 1 — Comparative stand of representative plants of upland rice grown in lots of different soil reactions: lot I — pH 5.3; lot II — pH 5.7; lot III — pH 6.2; lot IV — pH 6.4; control — pH 6.8; lot V — pH 6.9; lot VI — pH 7.1; lot VII — pH 7.3; lot VIII — pH 7.5.

The foregoing observations regarding color, tillering capacity, panicle count, and height showed that a pH range of 5.7 to 6.2 was best for upland rice under Los Baños conditions. In general, a pH beyond 6.9 was unsuitable for the growth of upland rice. These findings are in accord with those of Weir (1936).

The age of maturity was influenced by soil reaction. In general, acid reaction hastened maturity, whereas alkaline reaction delayed it. The ages of maturity in the different soil reactions were as follows: 115 days at pH 5.3 and 5.7; 115.8 days at pH 6.2; 118 days at pH 6.4; 120 days at pH 6.8, 6.9, and 7.1; 122.5 days at pH 7.3; and 138 days at pH 7.5. The observations showed that Inintiw rice grown in lots with acid reaction matured 10.9 days earlier than plants grown in lots with alkaline reaction.

The weights of one hundred sun-dried rice grains showed an insignificant difference in spite of the variable physiological characteristic of the plants from which they were harvested.

Sun-dried filled grains were pounded in a mortar until the hull was thoroughly removed. The clean rice was then powdered, sieved through a very fine abacá cloth, and the coarse particles powdered once more till practically all passed through the sieve. The rice powder was then stored in small, air-tight bottles. Total nitrogen was determined in accordance with the technique described by the Association of Official Agricultural Chemists (1935). The determination of phosphorus and iron contents of upland rice grains was carried out in accordance with the method of Morgan (1937) and that of lime by titrating with a standard soap solution.

The nitrogen content of the kernel of Inintiw rice varied from as low as 7.609 grams to as high as 14.705 grams per kilogram. There was no significant difference in the relative amounts of nitrogen in the different samples. This result seems to agree with the findings of Emmert (1931), who worked on lettuce and tomato, and of Arciaga and Galvez (1948) on pe-tsai. It differs, however, from the findings of Blair, Prince, and Winterberger (1937), who showed that the percentage of nitrogen in the dry matter of mixed hay and alfalfa increased as the pH of the soil increased; the lowest percentage was found in the samples from plots without lime. Shear (1938) reported the same results on annual garden flowers, except in the case of African marigold, calendula, and cosmos. In general, the amount of phosphoric acid was smaller in an alkaline reaction than in an acidic reaction. Emmert (1931) reported a similar result with lettuce and tomato plants; he found that the addition of lime caused an exceptionally low phosphate phosphorus content in plants. This result, however, differs from the findings of Shear (1938) regarding some annual flowers, like calendula, French marigold, zinnia, and cosmos, but agrees as regards the African marigold. It also differs from the results which Shear (1938) stated were reported in 1935 by Shive, Wadleigh and Travis, and by Arciaga and Galvez (1948).

The data indicate that although there seemed to be an increase in the lime in rice as the pH values increased, an analysis of variance showed that the increase was insignificant. This result conforms with the report of Shear (1938) on African marigold (crop for 1936), ageratum, calendula, scarlet sage, and nasturtium, all of which showed no significant difference in the calcium content of the sap, regardless of the reaction of the soil on which the plants were grown. Arciaga and Galvez (1948) found a similar tendency. Shear (1938) observed, however, that calcium in the zinnia,

castor bean, cosmos, French marigold, lupine, petunia, portulaca, balsam, and African marigold crop for 1937 increased as soil reaction increased.

In regard to the iron content of the rice, it was noted that this substance tended to decrease as the pH values increased from 5.3 to 7.1; there was no increase in iron in the rice at pH 7.3. This tendency corresponds to that in castor bean and lettuce as found by Shear (1938), and by Hardenburg as stated by Emmert (1931), respectively. Zimmerly (1930) cited Crist as reporting that heavy applications of lime greatly reduced the intake of iron.

SUMMARY

1. Upland rice, variety Inintiw, was grown on Los Baños clay loam having a pH range of from 5.3 to 7.5. During the booting stage of the plants, the soil reaction of the different lots tended to approach neutrality.

2. The soil reaction influenced the development of upland rice. The color, tillering capacity, number of panicles, and height of the plants grown in acidic reaction were, in all cases, better than the plants in lots with neutral or slightly alkaline reaction. Strongly alkaline reaction (pH 7.5) killed the rice plants. A pH range of 5.7 to 6.2 was the most suitable for the growth of the upland rice, variety Inintiw. Although soil reaction had a decided influence on the growth of the plants, it did not affect the weight of the grains. In general, an acidic reaction hastened maturity, whereas an alkaline reaction delayed it.

3. A proximate analysis of the Inintiw rice kernels harvested from lots of different soil reactions showed that the relative amounts of nitrogen seemed not to vary significantly, whereas the relative amount of phosphorus and iron content tended to vary significantly. The highest amount was found in samples harvested from lots with pH values ranging from 5.3 to 6.2. As the pH value decreased, the phosphorus and iron content decreased but the calcium content increased.

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HETEROSIS IN THE EGGPLANT¹

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WITH ONE TEXT FIGURE

Bayla (1918) reported that the F_1 hybrids from crosses between native and foreign eggplants were more vigorous and prolific than either parent plant.

Kakizaki (1931) found that the yield of varietal hybrids of the eggplant averaged 36.1 per cent more than the average of the parents, and 17 per cent or more than that of the higher-yielding parent.

With a view to discovering fruit and plant characters which may be enhanced by hybrid vigor and recommending the best varietal combination for utilization of hybrid seed in eggplant-improvement work, an experiment on intervarietal crosses of three varieties of eggplant—the Native Long Purple, the Long Green, and the Round Purple varieties—was performed in the culture plots of the Department of Agricultural Botany, College of Agriculture, Los Baños, Laguna, from May 23, 1947, to June 25, 1948.

MATERIALS

Native Long Purple variety

This variety is a coarse, usually branched, erect annual from 0.4 to 1 meter high, somewhat prickly or unarmed. The leaves are ovate to oblong-ovate, stellate-pubescent beneath, irregularly and shallowly lobed, about 10 to 25 centimeters long. The veins on the upper side of old leaves vary from green to light purple. The stem is light purple near the base and darker upward. The flowers are axillary, about 2.5 centimeters long, purplish or bluish. The fruit is fleshy and firmer in texture and has a sweeter taste than the Round Purple (New York Improved) variety. The fruit is smooth, purple, and globose to oblong or cylindric-oblong. The fruit has an average length of 16.64 centimeters and an average equatorial diameter of 3.65 centimeters. The seed material used in this experiment was obtained from the Department of Agronomy.

Long Green variety

This variety is also a coarse, usually branched, erect annual from 0.4 to 1 meter high, and also somewhat prickly or unarmed. The leaves possess the same characteristics as those of the Native Long Purple variety, except in the color of the veins, which are green both on the upper and lower sides

¹ Experiment Station Contribution No. 1539. Based on the thesis presented by the junior author for graduation with the degree of Bachelor of Science in Agriculture, October, 1948.

of the leaves. The stem is generally green. The flowers are light violet and axillary, from 1 to 2.5 centimeters long. The fruit is similar to the Native Long Purple variety, except that the former is green while the latter is purple. The seed material was also obtained from the Department of Agronomy.

Round Purple (New York Improved) variety

This variety is also a coarse, usually branched, erect annual about 70 centimeters tall, and somewhat prickly or unarmed. The leaves have also characteristics similar to those of the two varieties mentioned, except in the color of the petiole and veins on the upper side, which is dark purple. The stem is greenish purple throughout. The flowers are axillary, about 3.0 centimeters long, and light to dark purple. The fruit is fleshy, smooth, globular or roundish, and purple. It has an average equatorial diameter of 8.35 centimeters. The seed material was obtained from Calamba, Laguna.

EXPERIMENTAL PROCEDURE

Culture of the parental varieties

On May 27, 1947, the seeds from well-selected ripe fruits of the three varieties of eggplant were sparsely sown in seedboxes filled with pulverized and sterilized sandy loam soil. The seeds germinated in four to seven days.

The big and vigorous seedlings were selected and transplanted into the field on June 27, 1947, 50 centimeters from each other in furrows 75 centimeters apart. Transplanting was done late in the afternoon to prevent wilting. Six rows with 25 plants each were made. The first two rows were planted to the Round Purple variety, the second two rows to the Long Purple variety, and the third two rows to the Long Green variety. The plants were watered soon after transplanting and once a day until the plants had set firmly in the soil.

Cultivation and weeding were done two weeks after transplanting. All the plants were given the same field treatment until flowering time.

The best individuals from each of the parent plants in the different culture plots were examined before flowering and selected as parental types for hybridization.

Technique of cross-pollination

As dehiscence of the anthers occurred between six o'clock and ten o'clock in the morning and between two o'clock and three o'clock in the afternoon, the flower buds that were about to open were properly labeled early in the morning. In the afternoon, between four and five o'clock, they were emasculated and bagged.

The pistillate flowers to be emasculated were selected before they opened. Emasculation was done by opening the corolla lobes of the pistillate flowers with a pair of forceps and pulling out their five stamens one

at a time. The treated flowers were then covered at once with cellophane paper bags. During the operation, care was taken to minimize injury to the flower.

At about eight o'clock in the following morning when the stigma was highly receptive as indicated by the moist and sticky appearance of its surface, pollen from the stamens of bagged male parents of the same condition and age as the emasculated flower was transferred to the stigma of the female parent by gently rubbing the stamens of the male parent on the surface of the stigma of the emasculated flower. After cross-pollination, the treated flowers were bagged to prevent all possible causes of contamination. The untreated flowers in the same clusters were removed. The treated flowers were labeled with the combination accomplished, the date of emasculation, and the date of cross-pollination. They were frequently inspected to see the effect of the cross-pollination. The bags were removed when the corollas had withered and dropped off, leaving the young fruit on the plant.

Crosses performed

In this study, the Native Long Purple variety was the maternal or pistillate parent and the source of the hybrid seeds. The pollinators were the Round Purple and the Long Green varieties.

The following combinations were made:

- (1) Native Long Purple $\times$ Long Green variety
- (2) Native Long Purple $\times$ Round Purple variety

Parallel cultures of parental varieties and F_1 hybrids

Five hundred seeds of each of the following individual strains were sparsely sown in a separate seedbox of pulverized and sterilized sandy loam soil on December 22, 1947:

- (1) Native Long Purple variety
- (2) Long Green variety
- (3) Round Purple (New York Improved) variety
- (4) (Native Long Purple $\times$ Long Green) F_1 hybrid
- (5) (Native Long Purple $\times$ Round Purple) F_1 hybrid

The seeds germinated on December 26 to 29, 1947.

Twenty-five most vigorous seedlings from each variety were transplanted into the field on January 22, 1948, in 5 rows of 25 hills each. The seedlings were planted about 50 centimeters from each other in the rows about 75 centimeters apart, one strain to a row. The rows were so arranged that the F_1 plants lay between the corresponding parental types. Two blocks were utilized in parallel cultures of the strains.

The newly transplanted seedlings were shaded for four days and watered every day. The dead seedlings were replaced immediately.

Cultivation was done two weeks after transplanting, and weeding, occasionally, until flowering time.

Although the experiment was performed during the warmest months of the year, from January to June, the individuals in different populations exhibited sufficient variation to manifest obvious effects of heterosis.

RESULTS AND DISCUSSION

Comparison of parent strains and F_1 hybrids

Of 500 seeds from each strain, 93 per cent of the (Long Purple $\times$ Long Green) F_1 hybrid germinated, 88 per cent of the Long Green, 86 per cent of the Long Purple, 84 per cent of the (Long Purple $\times$ Round Purple) F_1 hybrid, and 79 per cent of the Round Purple variety. The highest percentage of germination of the (Long Purple $\times$ Long Green) F_1 hybrid was apparently a manifestation of early heterosis. The (Long Purple $\times$ Round Purple) F_1 strain had a slightly lower germination capacity than the pistillate parent strain (Long Purple variety), but it was relatively superior to the other parent (Round Purple) in the same respect.

No difference in growth between the hybrids and the parents was noted in the early stage of development. However, in the later stages of growth, marked differences in plant size between the hybrids and the parents were observed.

As a whole, the two types of first-generation hybrids flowered earlier than either parent. The first hybrid, (Long Purple $\times$ Long Green) F_1 , flowered about eight days earlier than the parental types. In the second cross, the hybrid (Long Purple $\times$ Round Purple) F_1 flowered about seven days earlier than the Long Purple variety, the pistillate parent, and about nine days earlier than the Round Purple variety, the staminate parent. Hybrid vigor on the basis of earliness in flowering was similarly manifested in the first-generation crosses. The same observation was reported by Capinpin and Sison (1947) on F_1 hybrids of tomato varieties.

The differences in the number of days of flowering of the different strains were highly significant.

As expected, the two kinds of F_1 hybrids formed fruit earlier than either of the parents. The (Long Purple $\times$ Long Green) F_1 progenies bore fruit in 65.12 days on the average, or about eleven days after flowering; this was about ten days earlier than the fruiting time of either of the parents. The other cross, the (Long Purple $\times$ Round Purple) F_1 hybrid, fruited in 68.36 days on the average, or about thirteen days after flowering; this was about eight days earlier than the fruiting time of the parental types. Capinpin and Sison (1947) reported a similar observation on F_1 hybrids of tomato varieties.

The differences in the number of days of fruiting of the five strains were highly significant.

The F_1 plants of the cross between the Long Purple and the Long Green varieties produced light purplish stems which were nearly of the same color of the pistillate variety (Long Purple). The dominance of purple over green was also manifested in the leaf. However, in the second cross, (Long Purple $\times$ Round Purple) F_1 hybrid, the plants produced a stem color similar to that of the male parent (Round Purple variety), although the parents differed only slightly in stem color. A similar phenomenon was observed in the leaf. It was evident that the gene or group of genes responsible for purple color was dominant over that for green or nonpurple.

In both cases, the F_1 plants produced stem diameters larger than either parent. Kakizaki (1931) reported similarly thus: "the stem diameters were in eight crosses less, in one cross the same, and in 19 crosses thicker than the median diameter of the parents, averaging an increase of 5.8 per cent."

There was no significant difference in both the size and shape of leaf.

Variation was observed in the color of the corolla and calyx. The F_1 plants in the two crosses produced corolla and calyx colors which were intermediate between those of the parent strains.

No variation in shape was noted between the cross of Long Purple $\times$ Long Green and either of the parents; however, a very distinct difference in color between the same cross and the parents was observed. The F_1 fruits had a light purplish tinge which was intermediate between the fruit colors of the parents.

In the other cross, (Long Purple $\times$ Round Purple) F_1 , no variation in color was observed but a deviation in shape was noted. The F_1 plants produced a semilong, pearshaped or oblong-ovate fruit which was intermediate in shape between the fruit of the parents (fig. 1.)

Boswell cites Nolla's (1937) finding that the purple color in the vegetative and floral parts was very closely linked with fruit color. It was suspected that the distribution of purple pigment in these parts was controlled by the same gene or group of genes. According to this relationship, fruits with purple skin were borne on plants with violet or purple corollas and calyxes and purple-tinged foliage. Green fruits were borne on pure-green plants with white corollas. The same phenomenon was observed in the plants studied. Since the populations under study were first-generation progeny, as well as pure cultures of parental varieties, it could not be ascertained whether the phenomenon was a case of linkage of genes for purple pigmentation in vegetative and floral parts or an example of pleiotropy. The segregating generation in the F_2 will show whether heredity would be of independent assortment or a case of linked inheritance, as measured by the relative proportion of recombination phenotypes. This phase of study is under observation by the senior author.

The height of the F_1 plants was measured from the base of the stem to the end of the flower head when they were four months and twenty-two days old. In both crosses, the hybrids were either as tall as or taller than either parent (table 3a). The increase in average height of the (Long Purple $\times$ Long Green) F_1 hybrid plants over the average height of the tallest of

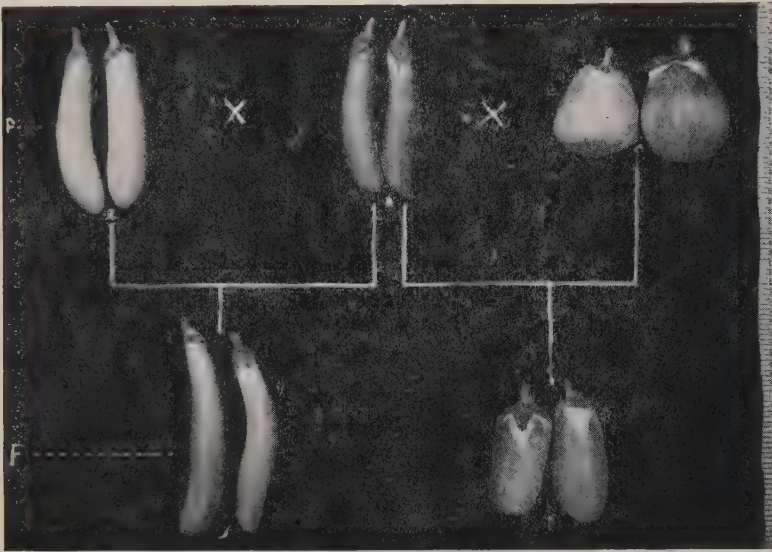


Fig. 1. — Parental types and F_1 hybrids of the eggplant varieties used. (a) Long Green, (b) Long Purple, (c) Round Purple, (d) (Long Purple $\times$ Long Green) F_1 hybrid, (e) (Long Purple $\times$ Round Purple) F_1 hybrid.

the three parent strains (the Long Purple variety) was 9.7 per cent. The increase was 15.2 per cent more than the average of the parents. The second hybrid, (Long Purple $\times$ Round Purple) F_1 , exhibited an average increase of 3.3 per cent over the average of the parents (table 3a).

The differences in plant height of the five strains were highly significant (table 3b).

Similar results were obtained by Kakizaki (1931), who found that the F_1 progenies of eggplant crosses showed a mean height increase of 6 per cent over the parents.

Both F_1 hybrid plants outyielded their productive parents five months from planting. The differences in yield of the five strains are highly significant (tables 4a and 4b). The (Long Purple $\times$ Long Green) F_1 progenies produced 54.5 per cent more than the lower-yielding parent and 25.5 per cent more than the higher-yielding parent; the yield was 38.5 per cent more than the average yield of the parents. The yield of the other cross, the

(Long Purple $\times$ Round Purple) F_1 hybrid, averaged 40.5 per cent more than that of the lower-yielding parent, 24.3 per cent more than the average of the parents, and 11.5 per cent more than that of the higher-yielding parent. The F_1 progenies in both crosses produced a greater number of fruit than the highest-yielding parent. The hybrids evidently exhibited heterosis on the basis of fruit production.

This observation confirms the findings of Kakizaki (1931) that the eggplant hybrids produced a greater number of fruit than either of the parents. He also reported that on the basis of the averages, the F_1 progenies were 36.1 per cent more productive than the parents and 17 per cent or more than the higher-yielding parent.

The lengths and diameters of the fruits of the hybrids and of both parents were measured with a wooden caliper graduated in centimeters. One of the hybrids, the (Long Purple $\times$ Long Green) F_1 , produced longer fruits than either of the parents. The other hybrid, (Long Purple $\times$ Round Purple) F_2 , produced fruits intermediate in size between those of the parents, that is, longer than the male parent's (the Round Purple variety) but shorter than the female parent's (the Long Purple variety) (table 5a). The average increase in length of the fruits of the first hybrid over the average length of the parents combined was 7.6 per cent; this is more than the 6.5 per cent increase over the average length of the fruits of the parent producing long fruits.

The differences between the mean lengths of the fruits of the five strains were highly significant (tables 5a and 5b).

There was no significant difference between the mean equatorial diameters of the fruits of the hybrid (Long Purple $\times$ Long Green) F_1 and of the parent varieties, the Long Green and the Long Purple, (tables 6a and 6b). This may be due to the fact that the fruits of both parents had no marked difference in equatorial diameter. However, a significant difference in the mean equatorial diameter of the fruit was found between the second hybrid and either of the parents. The mean equatorial diameter of the fruit of the (Long Purple $\times$ Round Purple) F_1 hybrid had an increase of 5.3 per cent over the average of the parents. It was 73.2 per cent higher than that of the smaller-diametered parent (Long Purple) and 32.1 per cent less than that of the larger-diametered parent (Round Purple).

The heterotic effect was evident in the weights of the fruits (tables 7a and 7b). The average fruit weight of the (Long Purple $\times$ Long Green) F_1 hybrid showed only an increase of 13.8 per cent over the average of the parents, or 12.2 per cent higher than that of the Long Green, the more productive parent. In the second cross, however, the mean weight of the fruits of the (Long Purple $\times$ Round Purple) F_1 hybrid was significantly more than that of the fruits of the female parent (Long Purple) but less than that of

the male parent (Round Purple). The increase over the female parent was 127.6 per cent, or 15.4 per cent higher than the average of the two parents combined.

The fruits of the hybrids had the quality and flavor of the female parent (Long Purple) and the sweetness and firmness of texture of the Long Purple variety. The Long Green variety, although not highly demanded in the market probably because of its color, is considered by some to possess similar or even better quality and flavor than the Long Purple. The fruits of both varieties are of the "boiling type." Their hybrid produced fruits possessing the sweetness and firmness of texture of both parents. The quality and flavor of the fruits of the hybrid (Long Purple $\times$ Round Purple) F_1 were intermediate between the parental varieties.

Two species of black beetles (*Psylliodes balyi* Jacoby and *Psylliodes splendida* Harold) which were found feeding on the plants in the earlier stage of growth decreased in number in the later stage of development of the plants. Lady beetles (*Ephilachna* spp.) were also noticed attacking the leaves of all strains during the fruiting stage. However, the damage caused by these insect pests was negligible. No disease affected the plants during the experiment.

SUMMARY

1. Heterosis was manifested by the first-filial-generation hybrids, (Long Purple $\times$ Long Green) F_1 and (Long Purple $\times$ Round Purple) F_1 , on the basis of the following:

(a) The percentage of germination was higher than that of both parents in the case of the (Long Purple $\times$ Long Green) F_1 . The other cross, the (Long Purple $\times$ Round Purple) F_1 hybrid, had a higher germination capacity than one of the parents and almost equal the other parent.

(b) The hybrids flowered and fruited earlier than their respective parents.

(c) The gene or group of genes responsible for the purple color was dominant over that for the green or nonpurple as indicated in the color inheritance of the stem, leaf, flower, and fruit.

(d) The hybrids were either as tall as or taller than either parent.

(e) Both hybrids produced a significantly greater number of fruits than either of the parents.

(f) The hybrid (Long Purple $\times$ Long Green) F_1 produced longer fruits than either parent; the hybrid (Long Purple $\times$ Round Purple) F_1 , fruits longer than those of the male parent (Round Purple) only.

(g) The hybrid (Long Purple $\times$ Round Purple) F_1 had a mean equatorial diameter greater than that of the female parent (Long Purple) only.

(h) The mean weight of the fruits of the (Long Purple $\times$ Round Purple) F_1 hybrid plants was significantly greater than the mean weight of the female parent (Long Purple) only.

2. The quality and flavor of the better-tasting parents were manifested by the F_1 hybrids.

3. All strains were equally resistant to the attack of pests and diseases.

4. The hybrid (Long Purple $\times$ Long Green) F_1 possessed desirable market qualities in shape, size, taste, and high productivity. It flowered and fruited the earliest among the five strains studied.

5. The (Long Purple $\times$ Long Green) F_1 hybrid may be recommended for practical utilization of seed in eggplant improvement work.

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TABLE 1a
Number of days of flowering of the five strains

PLANT NUMBER	STRAIN				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple × Round Purple) F ₁	Round Purple
1	71	48	53	50	60
2	52	48	56	50	60
3	52	48	63	51	57
4	64	52	66	52	58
5	64	51	63	54	62
6	68	55	57	51	55
7	55	51	62	60	54
8	66	56	57	51	66
9	60	49	56	51	63
10	54	56	66	50	63
11	67	51	61	56	67
12	62	56	55	52	67
13	56	56	64	56	72
14	70	50	73	62	62
15	64	50	55	58	64
16	73	55	65	58	67
17	74	54	54	63	62
18	55	53	71	52	74
19	57	52	54	63	70
20	58	59	70	50	62
21	58	50	58	65	74
22	68	65	65	52	68
23	66	59	66	63	69
24	65	61	57	50	73
25	57	59	68	64	66
Total	1556	1344	1535	1384	1615
Mean	62.24	53.76	62.14	55.36	64.60

TABLE 1b
Analysis of variance of the number of days of flowering of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains	4	2180.27	545.07	19.05	2.464	3.520
Between individuals	24	1064.75	44.36	1.55	1.634	2.020
Residual error	96	2746.13	28.60			
Total	124	5991.15				

L.S.M.D.—3.00

TABLE 2a
Number of days of fruiting of the five strains

PLANT NUMBER	STRAIN				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple × Round Purple) F ₁	Round Purple
1	66	58	83	63	73
2	69	58	67	63	72
3	75	60	68	65	70
4	79	64	77	65	70
5	76	63	78	67	75
6	71	65	81	64	68
7	77	62	69	70	68
8	73	67	78	65	78
9	71	61	71	65	75
10	80	68	68	64	75
11	76	63	79	69	78
12	67	68	74	66	78
13	77	68	70	69	82
14	83	62	81	73	72
15	69	65	78	71	76
16	78	64	83	72	78
17	66	63	84	75	75
18	82	63	69	67	84
19	68	64	71	75	80
20	80	69	72	63	75
21	72	62	73	76	84
22	79	75	80	66	79
23	80	71	78	76	80
24	72	73	79	63	83
25	80	72	73	77	78
Total	1866	1628	1884	1709	1906
Mean	75.44	65.12	75.36	68.36	76.24

TABLE 2b
Analysis of variance of the number of days of fruiting of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains	4	2420.13	605.03	25.27	2.464	3.520
Between individuals	24	884.21	36.84	1.12	1.634	2.020
Residual error	96	2298.27	23.94			
Total	124	5602.61				

L.S.M.D.—2.73

TABLE 3a
Height (in centimeters) of the plants of the five strains

PLANT NUMBER	STRAIN				
	Long Green	(Long Purple / Long Green) F ₁	Long Purple	(Long Purple X Round Purple) F ₁	Round Purple
1	68.5	81.0	66.5	75.5	70.0
2	67.0	78.0	76.5	70.5	70.5
3	65.5	79.5	70.0	69.0	64.5
4	68.5	78.5	71.0	76.5	65.0
5	65.0	80.0	72.0	69.0	63.0
6	62.0	80.0	75.5	75.0	62.0
7	65.0	78.5	72.0	77.0	67.5
8	68.0	79.5	76.0	69.5	72.0
9	59.5	82.5	68.0	69.5	69.5
10	67.0	78.0	72.0	70.0	67.5
11	66.5	80.5	75.5	75.0	68.5
12	59.5	77.0	67.0	72.0	62.5
13	60.0	78.5	71.0	68.0	65.5
14	62.0	78.0	69.0	69.5	72.0
15	60.0	82.0	72.5	75.0	63.0
16	59.0	72.0	73.5	75.0	72.5
17	62.0	79.0	66.0	71.5	63.0
18	63.0	81.5	70.0	70.5	64.5
19	68.0	82.5	75.0	68.0	66.0
20	64.0	76.0	71.0	75.0	69.5
21	63.0	72.0	72.5	69.5	66.5
22	66.5	77.5	72.5	68.0	68.0
23	67.5	76.0	71.0	70.0	72.0
24	72.0	74.0	75.5	74.5	69.5
25	63.0	72.0	69.0	72.0	68.0
Total.....	1612.0	1954.0	1781.0	1795.5	1695.5
Mean.....	64.48	78.16	71.24	71.82	67.82

TABLE 3b
Analysis of variance of the heights of the plants of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					05	01
Between strains	4	2887.24	721.81	31.24	2.464	3.520
Between individuals	24	206.49	8.60			
Residual error	96	2217.62	23.10			
Total	124	5311.35				

L.S.M.D.—2.68

TABLE 4a
Number of fruits produced by each of the five strains

PLANT NUMBER	STRAIN				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple × Round Purple) F ₁	Round Purple
1	8	10	5	10	6
2	6	8	6	10	5
3	5	8	8	9	5
4	6	8	10	6	5
5	5	10	5	7	5
6	4	8	6	7	4
7	5	8	7	5	7
8	6	9	6	8	8
9	5	10	11	8	5
10	7	9	8	6	5
11	6	8	6	9	9
12	5	10	7	9	3
13	3	8	7	5	5
14	3	9	8	7	3
15	5	7	6	8	4
16	5	7	6	6	4
17	5	6	5	8	5
18	5	7	6	5	5
19	4	7	7	9	5
20	6	9	5	8	5
21	5	8	5	8	6
22	5	7	5	8	4
23	7	8	4	7	5
24	7	10	9	6	7
25	6	8	6	5	6
Total.....	134	207	165	184	131
Mean.....	5.36	8.28	6.60	7.36	5.24

TABLE 4b
Analysis of variance of the number of fruits produced by each of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains.....	4	169.56	42.39	23.68	2.464	3.520
Between individuals.....	24	62.68	2.61	1.45	1.634	2.020
Residual error.....	96	172.44	1.79			
Total.....	124	404.68				

L.S.M.D.—0.75

TABLE 5a
Length (in centimeters) of the fruits of the five strains

PLANT NUMBER	STRAIN				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple × Round Purple) F ₁	Round Purple
1	15.5	16.5	15.5	13.5	9.5
2	17.0	18.0	18.1	13.0	9.0
3	16.0	21.8	15.7	11.4	9.0
4	16.6	21.0	15.8	12.6	10.5
5	14.1	18.1	13.2	14.5	9.5
6	15.5	16.5	16.9	12.5	8.5
7	19.0	15.2	18.0	12.0	9.0
8	18.8	19.3	15.0	13.0	11.0
9	20.1	18.1	19.1	12.8	9.5
10	14.8	16.5	17.5	14.6	10.0
11	15.5	16.8	16.5	13.5	10.0
12	17.2	15.9	15.0	14.0	8.7
13	18.0	22.0	16.3	12.3	11.5
14	16.5	18.5	14.5	12.2	10.5
15	16.2	18.3	18.4	13.5	9.0
16	20.0	19.1	13.7	10.9	9.6
17	15.9	16.7	14.8	12.0	10.5
18	18.4	15.9	17.9	11.4	10.0
19	18.6	18.4	15.5	11.5	9.5
20	20.0	16.8	19.5	12.0	9.9
21	17.1	21.1	18.5	12.6	11.2
22	15.2	20.6	18.4	13.0	9.5
23	17.1	18.5	17.5	13.0	9.8
24	16.0	15.9	17.9	14.5	10.1
25	15.0	16.4	17.0	12.0	9.5
Total.....	424.1	451.9	416.2	318.3	243.9
Mean.....	16.96	18.07	16.64	12.73	9.75

TABLE 5b
Analysis of variance of the length of the fruits of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains.....	4	1213.56	303.39	129.65	2.464	3.520
Between individuals.....	24	50.63	2.11			
Residual error.....	96	225.56	2.34			
Total.....	124	1489.75				

L.S.M.D.—0.85

TABLE 6a
Equatorial diameter (in centimeters) of the fruits of the five strains

PLANT NUMBER	STRAINS				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple × Round Purple) F ₁	Round Purple
1	3.5	4.0	3.5	7.0	8.5
2	4.0	4.0	4.0	6.5	7.6
3	3.5	4.6	3.5	5.5	8.0
4	4.0	4.0	3.5	6.0	9.0
5	3.0	4.0	3.0	7.6	8.4
6	3.0	4.0	4.0	6.0	7.3
7	4.0	3.5	4.0	5.5	7.5
8	4.0	4.0	3.5	6.0	9.7
9	4.2	4.0	4.0	6.0	8.0
10	3.0	3.5	4.0	8.0	8.5
11	3.0	3.6	3.7	6.8	8.0
12	4.0	3.0	3.0	7.1	7.4
13	4.0	4.5	3.5	6.0	10.2
14	4.0	4.0	3.0	6.0	8.8
15	3.7	4.0	4.0	6.5	8.0
16	4.0	4.1	3.0	6.0	8.0
17	3.5	3.5	3.0	6.0	8.3
18	4.0	3.0	4.0	5.5	8.5
19	4.0	4.0	3.5	5.5	7.8
20	4.0	4.0	4.0	5.8	8.5
21	4.0	4.2	4.0	6.0	9.5
22	3.5	4.0	4.0	6.8	8.2
23	3.5	4.0	4.0	6.5	8.4
24	4.0	3.0	3.5	7.5	8.5
25	3.0	3.5	4.0	5.9	8.2
Total.....	92.4	96.0	91.2	158.0	208.8
Mean.....	3.69	3.84	3.65	6.32	8.35

TABLE 6b
Analysis of variance of the equatorial diameters of the fruits of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains.....	4	342.64	85.66	63.91	2.464	3.520
Between individuals.....	24	5.63	0.23			
Residual error.....	96	129.47	1.34			
Total.....	124	477.74				

L.S.M.D.—0.64

TABLE 7a
Weight (in grams) of the fruits of the five strains

PLANT NUMBER	STRAINS				
	Long Green	(Long Purple × Long Green) F ₁	Long Purple	(Long Purple Round Purple) F ₁	Round Purple
1	80.5	85.9	76.2	260.5	256.8
2	96.6	92.3	110.8	245.2	245.0
3	87.5	154.8	85.1	153.0	260.5
4	90.5	138.1	80.0	238.9	324.6
5	70.8	120.5	70.8	292.5	252.1
6	75.0	93.2	90.2	224.6	185.0
7	130.7	81.3	107.4	158.1	221.5
8	125.5	126.8	74.5	224.8	327.8
9	142.5	88.2	130.4	192.6	230.2
10	73.0	82.1	96.9	320.2	325.0
11	78.0	85.0	82.0	251.9	318.7
12	105.5	77.9	75.6	287.1	187.9
13	90.8	169.3	80.2	164.0	358.4
14	83.0	136.7	75.3	182.5	323.1
15	82.0	127.0	112.6	230.4	210.5
16	136.8	140.2	72.0	178.4	249.5
17	78.6	82.6	76.7	158.6	310.5
18	120.3	78.5	115.5	148.2	338.7
19	122.0	111.7	78.0	157.0	236.5
20	134.2	95.0	135.2	160.0	296.5
21	90.1	145.5	120.5	201.5	341.5
22	80.6	136.5	117.8	246.5	263.5
23	85.8	118.5	101.2	211.2	282.3
24	85.0	75.2	91.5	312.6	330.0
25	80.0	77.9	100.3	163.0	265.9
Total	2425.3	2720.7	2356.7	5363.3	6942.0
Mean	97.01	108.83	94.26	214.53	277.68

TABLE 7b
Analysis of variance of the weights of the fruits of the five strains

SOURCES OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	VARIANCE	COMPUTED F	TABULAR F	
					.05	.01
Between strains	4	653,332.06	163,333.01	224.73	2.464	3.520
Between individuals	24	22,925.97	955.24	1.31	1.634	2.020
Residual error	96	70,159.55	731.23			
Total	124	746,417.63				

L.S.M.D.—15.16

THE RAPID DISSEMINATION OF THE MOSAIC DISEASE OF ABACÁ, OR MANILA HEMP PLANT (*MUSA TEXTILIS* NÉE), IN THE FIELD¹

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In 1941 the Japanese abacá planters claimed that 50 per cent of the abacá plants in the eastern part of Davao Province in Mindanao were infected. Since the liberation of the Philippines in 1945, varied alarming reports have been made of the destructiveness of the disease, from 90 per cent of the plants in some plantations to almost total infection in others.

In this paper the writer summarizes briefly the results of experiments, which, it is believed, suggest the sources of inoculum, the agents of dissemination, and the chief reason for the rapid regional spread of the disease. With this information it is hoped that means for reducing the injury from the disease may be adopted and the regional spread of the disease minimized. The experiments were conducted under controlled conditions in the Department of Plant Pathology, College of Agriculture.

As previously reported by us (1938, 1940, 1941), abacá mosaic is caused by a strain of the virus *Marmor cucumeris* Holmes. The origin of the disease is not known. In experimental transmission under controlled conditions we found that the virus may be transmitted from abacá to abacá by *Aphis gossypii* Glover, *Rhopalosiphum nymphaeae* (Linn.), and *R. prunifoliae* Fitch.

The finding in 1937 of wild *Canna indica* Linn. infected with mosaic disease among the abacá plants in Davao aroused the suspicion that the mosaics of the two hosts may be related to each other. Hence, cross-transmission experiments were carried out in the laboratory at Los Baños, to determine whether or not *Canna indica* mosaic could be transferred to abacá and vice versa.

Further experimental transmission showed that *Aphis maidis* Fitch, one of the vectors of grass mosaic, is capable of transmitting the mosaic of corn to abacá and from abacá back to corn. Also, one of the vectors of abacá mosaic, *Aphis gossypii*, can transmit the mosaic disease from corn to corn.

THE EXPERIMENTAL TRANSMISSION TESTS CARRIED OUT AT LOS BAÑOS

The results of our transmission experiments may be summarized as follows:

¹ Experiment Station Contribution No. 1540.

On Abacá

1. *Aphis gossypii* Glover can transmit the mosaic disease from abacá to abacá.
2. *Rhopalosiphum nymphaeae* (Linn.) and *R. prunifoliae* Fitch can transmit the mosaic disease from abacá to abacá.
3. *Aphis maidis* Fitch can transmit the mosaic from corn to abacá and back to corn.

On Canna spp. and varieties

1. *Aphis gossypii* can transmit the mosaic from *Canna indica* to abacá, *Canna edulis*, and ornamental varieties of *Canna*; but it can not transmit the mosaic disease from abacá to *Canna edulis* and ornamental varieties of *Canna*.
2. *Aphis maidis* can transmit the mosaic virus from *Canna indica* to abacá.

On Corn

1. *Aphis maidis* can transmit the virus of the mosaic from abacá to corn and back to abacá.
2. *Aphis gossypii* can transmit the mosaic virus from corn to corn.

The results of experimental transmission show that at least four species of aphids can transmit the mosaic disease of abacá — two from abacá to abacá and two from *Canna indica* and corn to abacá. Under field conditions, some of these aphids may not be important as vectors of the mosaic disease because abacá is probably not a normal host of these insects. Under stress of absence of their customary hosts, however, they may provisionally take to feeding on abacá and in this way transmit the mosaic from abacá to abacá, or from any other source of inoculum to abacá.

The results further show that the proximity to abacá fields of *Canna indica* and of corn is to be viewed with concern because the mosaics of these plants can be transmitted to the abacá by the appropriate aphid vector. It appears that the mosaic of abacá may be caused by *Marmor cucumeris*, modified by association with other hosts or by the grass mosaic from corn and other graminaceous weeds. In formulating measures for eradicating the mosaic of abacá, or for protecting the healthy plants from infection, the presence of wild *Canna indica* and the planting of corn in fields bordering abacá plantations should be discouraged. Graminaceous weeds should not be tolerated in abacá plantations.

METHODS OF SPREAD OF THE MOSAIC DISEASE IN THE FIELD AND IN NEW AREAS

Insect vectors are responsible, to a large extent, for the spread of the mosaic disease from abacá to abacá or from other host species to abacá. However, the dissemination of the mosaic to widely separated fields and

the introduction of the disease in newly opened areas are not primarily due to the virus carried by the vectors from mosaic-infected plantations. The dissemination and introduction in new areas are due to the suckers taken from superficially healthy but infected stools in which the symptoms are easily overlooked or not yet sufficiently clear to attract the attention of the inexperienced farm hand. By far, the most important cause of the rapid spread of the disease to other fields or localities is the use of suckers in the incipient stages of mosaic infection.

THE CONTROL OF THE MOSAIC DISEASE OF ABACÁ BY RUNNING AWAY
FROM THE DISEASE

Some abacá planters believe that one of the methods for controlling the mosaic disease is to shy away from it. Thus, they open up new areas and plant suckers taken from apparently healthy stools. Had it been possible to select absolutely mosaic-free suckers, the new field could be kept safe from the disease by a regimen of spraying with aphicides, such as soap solution, tobacco decoction or Black Leaf "40". Unfortunately, such oversimplification of control is not entirely dependable because suckers may have been taken from already infected stools but which, for some reason, are not yet showing the tell-tale signs of mosaic. The difficulty of securing absolutely clean suckers is multiplied when large areas are opened up because the chances of securing large numbers of suckers, all of them healthy, are thereby reduced.

SUMMARY

1. Abacá planters should discourage wild *Canna indica* Linn. and graminaceous weeds in or near abacá fields. Neither should corn be planted close to abacá plantations because the mosaics of these plants, *Canna indica* and corn, can be transmitted to abacá by their insect vectors.

2. The most important agency that spreads the mosaic disease from field to field and from one area to another is not so much the insect vectors as the abacá planter himself who uses suckers taken from stools with incipient stages of the disease.

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COLLEGE AND ALUMNI NOTES

A number of the United States Fish and Wildlife Service personnel, with their families, visited the College on July 2, 1949. The party was headed by Dr. Herbert W. Graham.

The student body of the College elected the new officers for the first semester of 1949-50 on July 18, 1949. The officers-elect were: Augusto Gonzalez, president; Clemente Juliano, Jr., vice-president; Raymundo Jovellanos, secretary; Rosario Aspiras, treasurer; Oscar Mabanag and Leandro Sinco, U.P. Student Council representatives; and David Daza, Collegian representative. Dr. J. M. Capinpin is the adviser of the Student Body Organization.

In the different class organizations, the following were elected presidents and advisers for the first semester of 1949-50: Freshman — Juan J. Carurucan, president and Dr. S. M. Cendaña, adviser; Sophomore — Quirino Villaviza, president and Dr. F. M. Sacay, adviser; Junior — Prospero Pajarillaga, president and Mr. N. B. Tablante, adviser; Senior — Jose Berenguer, president and Professor A. B. Catambay, adviser.

Dr. Ralph E. Turner, Durfee professor of history at Yale University, was a special campus visitor on July 29, 1949. He conferred with the department heads and faculty of the College on the dissemination of scientific agriculture to the Filipino masses, in connection with his investigation of contemporary cultural change in the Philippines. After the conference, he presided over an open forum of the student body at the Chemistry Lecture Hall.

Dr. Dioscoro L. Umali, '39, a fellow of the University, has recently returned from the United States, and is now with the staff of the Department of Agronomy. He took his doctor's degree from Cornell University, New York, where he specialized in plant breeding.

Three members of the College faculty left on S. S. *General Gordon* on August 8, 1949, to pursue postgraduate studies in the United States. They are: Miss Clare R. Baltazar, '47, *summa cum laude*, of the Department of Entomology, who will specialize in economic entomology at the University of Wisconsin; Mr. William L. Fernandez, '46, *magna cum laude*, of the Department of Plant Pathology, who will specialize in industrial bacteriology at the University of Missouri; and Miss Nelly Dunglao (B.S.E., *cum laude*), of the Department of Languages, who will pursue postgraduate courses in English at the Northwestern University in Evanston, Illinois.

Miss Luz A. Uichanco, '48, *magna cum laude*, daughter of Dean Uichanco, was one of those who sailed on S. S. *General Gordon* for the United States on August 8, 1949. She will take postgraduate work in chemistry at the University of Michigan.

The new members who have been added to the College faculty are: Miss Carmen R. Alcaraz, B.S.H.E. graduate from U.P. '49, effective July 20, 1949, vice Miss Anacoreta Ablaza, home economics instructor in the Rural High School, who resigned last July 16; Mr. Pablo J. Alfonso, Jr., '49, assistant instructor in the Department of Entomology and Zoology, effective July 6, 1949; and Mr. Laureano Bondoc, '49, assistant instructor in the Department of Agronomy, effective August 1, 1949.

In the 185th scientific meeting of the Los Baños Biological Club, held at the Chemistry Lecture Hall on July 29, 1949, the paper read and discussed was: "Fresh meat supply of the City of Baguio," by Dr. Valente Villegas, head of the Department of Animal Husbandry, and Dr. Cipriano A. Flores, city veterinarian, Baguio. In the 186th scientific meeting held in the Entomology Lecture Hall on September 30, 1949, "A field test of four varieties of sugar cane", by Dr. V. C. Calma and Mr. Federico V. Ramos was read by Dr. Calma.

In a meeting of the stockholders of the Maquiling School, Inc. on August 5, 1949, the following were elected members of the Board of Trustees: Dr. L. B. Uichanco, Dr. F. M. Sacay, Dr. F. M. Fronda, Judge Paulo Macasaet, and Professor M. A. Gapud.

In a meeting of the Board of Trustees on August 12, the following were reelected officers: Dr. L. B. Uichanco, president; Dr. F. M. Sacay, vice-president-director; and Dr. F. M. Fronda, secretary-treasurer.

Several associations elected their officers and advisers for the school year 1949-1950. The leaders-elect and advisers are as follows: Ranchers' Club—Alfonso Dingayan, governor and Dr. F. Mensalvas, adviser; Soil Tillers' Photographic Club—Efren Sibayan, president and Mr. A. P. Varona, adviser; Speech and Dramatics Club—Thomas Flores, president and Mrs. M. I. Sevilla, adviser; Philippine Country Life Association—Manuel Mallorca, president and Dr. F. M. Sacay, adviser; Mimes-Mummers-Scribblers Fraternity—Roberto Fronda, grand consul and Dr. Dioscoro Umali, moderator.

The following students were awarded scholarships in the College for the first semester, academic year 1949-1950; University scholarship—Pedro B. Esecuro and Jose O. Juliano; College scholarship—Macario T. Ilaga and Quirino H. Villaviza; Entrance scholarship—Zenaida V. Alcala, Igmidio T. Corpuz, Alfredo L. Eloja, Efrain C. Guanco, Isidoro M. Jose, Constantino F. Lucero, Domingo G. Molina, Amado M. Montemayor, Miguel P. Palao, Martin E. Raymundo, Maximino P. Sanchez, and Gabriel A. Tablinga.

Among the arrivals on the S.S. *President Cleveland* last August 24 were the following alumni: Dr. Jose R. Velasco, '40, who finished his doctor's degree from the University of California; Mr. Julian Bulanadi, '35, who specialized in agricultural engineering at the Iowa College of Agriculture; Mr. Crispin Las Marias, '36, who finished his master's degree, major in agricultural engineering, at the Texas Agricultural and Mechanical College; and Mr. Hilario J. Santos, '36, who took his master's degree, major in vocational education, at the Colorado Agricultural and Mechanical College. Doctor Velasco was a fellow of the U. S. State Department and of the University of the Philippines, and Mr. Las Marias, a government pensionado.

Dr. Otto A. Reinking, first professor and head of the Department of Plant Pathology, visited the campus on September 7, 1949. After paying his respects to Dean L. B. Uichanco, Doctor Reinking conferred with Dr. G. O. Ocfemia on the bunchy-top and mosaic diseases of abacá. Doctor Reinking joined the faculty of the College in 1916. He resigned in 1923 to become plant pathologist of the United Fruit Company. He first revisited the Philippines in 1925. He is at present chief plant pathologist of the New York State Agricultural Experiment Station at Geneva.

Dr. Mordecai Ezekiel, chief of the economic analysis branch of the FAO, was a campus visitor on September 21, 1949. He conferred with Dr. F. M. Sacay and inquired about the possibilities of accommodating on the campus students from countries in Southeast Asia who will attend an institute of economic research being planned by the FAO.

The College celebrated its 31st annual Loyalty Day on October 10, 1949, despite the absence of the guest of honor, Hon. José Yulo, who was unable to attend on account of illness.

In the absence of Hon. José Yulo, President B. M. Gonzalez delivered an extemporaneous address. Mr. N. B. Tablante gave the opening remarks, and Dean L. B. Uichanco administered the Oath of Loyalty. Musical numbers were rendered by the Camp Murphy Band, conducted by Major L. G. Cariño, and by Misses Corazon Libunao, Adoracion Musa, Lourdes Corpus, and Andrea Ofilada, all of the U.P. Conservatory of Music.

About one hundred alumni from the different parts of the Philippines, excluding those connected with the College, participated in the Loyalty Day celebration last October 10. Among those present were the following: Class of 1911—Jose F. Zamora; 1913—Bienvenido M. Gonzalez; 1914—Francisco G. Galang, Gonzalo Merino, Jose S. Camus; 1915—Severo M. Capistrano, Francisco D. Marquez, Pedro Montellano; 1916—Marcelino Constantino; 1918—Claro C. Samonte, Jose M. Trinidad; 1919—Joaquin J. Gonzalez II, Jose Noguera, Emiliano F. Roldan, Deogracias V. Villadolid; 1921—Dionisio I. Aquino, Nemesio Catalan, Severo Marquez, Quirino P. Ricafrente, Juan O. Unite, Eligio C. Ureta; 1923—Pablo N. Mabbun,

Apolinar S. Talento; 1924—Basilio Hernandez, Canuto G. Manuel; 1925—Cornelio V. Crucillo, Gonzalo H. Salazar; 1926—Federico P. Goseco; 1927—Quintin A. Eala, Fernando Ordoveza, Pedro S. Paje; 1928—Roberto C. Betia, Felix F. Villa; 1929—Dimas Maulit, Albino Vidal; 1930—Artemio E. Gesmundo, Jacinto B. Leoncio, Severino L. Salvador, Manuel B. Villano; 1931—Santiago R. Capco, Jose L. Morales; 1932—Rafael T. David, Florencio G. Gopez, Sabas P. Tangco; 1923—Luis A. Aldea, Elena Caguicla, Salvador B. Oliveros, Guillermo O. Palis; 1934—Leopoldo Alicbusan, Celestino T. Reantaso, Nicomedes C. Reyes, Jose K. Santiago, Generoso F. Tanseco, Alfonso L. Tecson; 1935—Alberto C. Felix, Cenon R. Floreruz, Paulino A. Guerrero, Arcadio F. Querijero, Bonifacio T. Yñiguez; 1936—Jose E. Borromeo, Flaviano P. Olivares, Demetrio S. Santos; 1937—Basilio M. Balisico, Amando M. Dalisay, Conrado C. Dinulos; 1939—Angel S. Huertas, Amando E. Libunao, Ramon Samaniego, Ascario G. Tuason; 1941—Porfirio T. Lazaro, Pericles S. Subido; 1942—Serapio Bayubay; 1946—Melchor E. Fronda, Celso G. Santos, Rufo H. Ocfemia; 1947—Ciriaco M. Lawas; 1948—Mario R. Belisario, Renato I. Capinpin, Teodomero M. Yñiguez.

All the alumni on the teaching staff of the Trinidad Agricultural High School in Mountain Province could not attend the Loyalty Day but they sent Mr. Serapio Bayubay, '42, to deliver a letter containing greetings and best wishes for a successful celebration. The letter was signed by Messrs. Luis J. Dangilan, '24, Constancio T. Medrana, '27, (principal); Juan S. Padilla, '32; Raymundo S. Laher, '37, Felix V. Remigio, '38; Santos G. Llana, '45; Doroteo Asuncion, '46; Crispin Cabanilla, '47; and Fernando Cuaresma, '48.

Telegrams of felicitation and renewal of pledge of loyalty to the College were received from Messrs. Felix N. Salcedo, '36, Modesto Ragat, '39, and Nicomedes Pizarro, '42, of the San Marcelino Rural High School in Zambales; Mr. Felipe Valdez, of La Carlota, Negros Occidental; and Messrs. Agustin M. Escarilla, '41, Saturnino G. Rico, '45, and Guillermo D. Valdez, '36, of the Iloilo High School.

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